

PALÆONTOGRAPHICAL SOCIETY.

VOL. LVII.

FOSSIL FISHES OF THE ENGLISH
CHALK.

PART II.

PAGES 57—96; PLATES XIV—XX.

CRETACEOUS LAMELLIBRANCHIA OF
ENGLAND.

PART V.

PAGES i—xlili, 197—232; PLATES XXXIX—XLII.

BRITISH CARBONIFEROUS
LAMELLIBRANCHIATA.

VOL. II, PART II.

PAGES 35—124; PLATES VII—XXI.

CARBONIFEROUS CEPHALOPODA
OF IRELAND.

PART V.

PAGES 147—234; PLATES XL—XLIX.

LOWER PALÆOZOIC TRILOBITES

OF THE

GIRVAN DISTRICT, AYRSHIRE.

PART I.

PAGES I—48; PLATES I—VI.

BRITISH GRAPTOLITES.

PART III.

PAGES xxix—lii, 103—134; PLATES XIV—XIX.

ISSUED FOR 1903.

California Academy of Sciences

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December _____, 1906.

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PALÆONTOGRAPHICAL SOCIETY.

VOLUME LVII.

CONTAINING

1. THE FISHES OF THE ENGLISH CHALK. Part II. By Dr. A. SMITH WOODWARD. Seven Plates.
2. THE CRETACEOUS LAMELLIBRANCHIA. Part V. By Mr. H. WOODS. Four Plates.
3. THE CARBONIFEROUS LAMELLIBRANCHIATA. Vol. II, Part II. By Dr. WHEELTON HIND. Fifteen Plates.
4. THE CARBONIFEROUS CEPHALOPODA OF IRELAND. Part IV. By Dr. A. H. FOORD. Ten Plates.
5. THE LOWER PALÆOZOIC TRILOBITES OF GIRVAN. Part I. By Mr. F. R. COWPER REED. Six Plates.
6. BRITISH GRAPTOLITES. Part III. By Miss ELLES and Miss WOOD. Edited by Prof. LAPWORTH. Six Plates.

ISSUED FOR 1903.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

AGENTS FOR THE SOCIETY:

DULAU AND CO., 37, SOHO SQUARE, W.

DECEMBER, 1903.

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Subscriptions are considered to be due on the 1st of January in each year.

The Annual Volumes are now issued in *two forms of Binding*: 1st, with all the Monographs stitched together and enclosed in one cover; 2nd, with each of the Monographs in a paper cover, and the whole of the separate parts enclosed in an envelope. Members wishing to obtain the Volume arranged in the LATTER FORM are requested to communicate with the Secretary.

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The Lower Palæozoic Trilobites of Girvan, by Mr. F. R. Cowper Reed.

The Cretaceous Lamellibranchia, by Mr. H. Woods.

The Carboniferous Lamellibranchiata, by Dr. Wheelton Hind.

The Inferior Oolite Ammonites, by Mr. S. S. Buckman.

The Sirenoid Ganoids, the Palæoniscid Fishes of the Carboniferous Formation, and the Fishes of the Old Red Sandstone, by Dr. R. H. Traquair.

The Fishes of the English Chalk, by Dr. A. Smith Woodward.

The Fauna of the Devonian Formation of the South of England, by the Rev. G. F. Whidborne.

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The Reptilia of the Oxford Clay, by Dr. C. W. Andrews.

The Cornbrash Fauna, by Prof. J. F. Blake.

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ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1903,

WITH A

L I S T

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY
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ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR ENDING 31ST MARCH, 1903.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE,
26TH JUNE, 1903.

Dr. HENRY WOODWARD, F.R.S., PRESIDENT,

IN THE CHAIR.

THE COUNCIL, in presenting their Fifty-sixth Annual Report, have much pleasure in referring to the satisfactory condition of the Society. It is true that the expenditure for the past year exceeded the receipts; but a considerable balance remained to the Society's credit during each of the two preceding years, and the Council decided to expend some of this surplus in enlarging the volume for 1902. They were thus enabled to publish important new matter which would otherwise have been delayed, and they arranged the Monographs to embrace a wider range of subjects than usual.

The total income for the financial year was £529 14s. 6d., and the total expenditure was £685 16s. 4d., necessitating the removal of £156 1s. 10d. from the Society's balance. This balance amounted to £1127 2s. 2d. on 31st March, 1902, and at the last Annual General Meeting it was resolved to invest a portion by the purchase of £500 Stock. The Officers, in consultation with the Bankers, accordingly purchased £500 Natal 3 per cent. Consolidated Stock, 1929—1949, on 3rd July, 1902. The price of this Stock was £487 10s., and the Brokers' charges

amounted to £1 6s. The Society now holds an investment for the first time in its history.

The total cost of the printing, illustrating, binding, and distribution of the volume for 1902 was £563 6s. 8*d.* It included no less than forty-eight plates, of which six (illustrating the Cave Hyæna) had been left on the stone for more than thirty years. Other old drawings still remain to be used, and the Council hope to be able to arrange for the publication of these without much further delay. Illustrations must necessarily be prepared sometimes well in advance, but special care is now taken to prevent their progressing more rapidly than the explanatory text.

The reduction in the receipts from subscriptions and sales (a loss of £91 3s. 5*d.* compared with last year) is probably to be explained by the fact that some subscribers contribute at irregular times, occasionally before, occasionally after March 31st, and that purchases are not always made with regularity. At the same time, several Public Libraries have again notified their intention to cease their subscriptions, and the new members barely compensate for the resignations. For the success of the Society's work it is still necessary to enlist the sympathies and obtain the personal subscriptions of all who are interested in the progress of palæontological science. The older members are being rapidly removed by death, and the Society has this year to deplore the loss of a Vice-President, the Rev. Dr. Wiltshire, who died on October 27th, 1902. His valuable services as Secretary, for a period of 37 years, will always be gratefully remembered.

The scientific work of the Society proceeds with undiminished vigour, and the Council have the gratification of receiving more offers of valuable matter than they can accept for immediate publication. Active progress is at present being made with Monographs of Pleistocene Mammalia, Cretaceous and Palæozoic Fishes, Carboniferous and Jurassic Mollusca, the Cornbrash Fauna, Ordovician and Cambrian Trilobites, and Graptolites. Other subjects are also being treated more slowly.

Thanks are due to the Geological Society for permission both to store the stock of back volumes and to hold the Council Meetings and the Annual General Meeting in their apartments.

In conclusion, it is proposed that the retiring members of the Council be Mr. Hudleston, Professor Lapworth, Rev. G. F. Whidborne, and Rev. A. Fuller; that the new members be Professor Boyd Dawkins, Rev. J. F. Blake, Dr. Wheelton Hind, and Mr. F. W. Rudler; that the President be Dr. Henry Woodward; the new Vice-Presidents, Dr. Blanford, Professor Boyd Dawkins, and Dr. G. J. Hinde; the Treasurer, Mr. R. Etheridge; and the Secretary, Dr. A. Smith Woodward.

Annexed is the Balance Sheet.

THE PALEONTOGRAPHICAL SOCIETY IN ACCOUNT WITH ROBERT ETHERIDGE, ESQ., TREASURER.

Cr.

Year ending March 31st, 1903.

Dr.

Balance from last Account—					£	s.	d.		£	s.	d.	
On Deposit					900	0	0	Purchase of £500 Natal 3 per cent. Stock	488	16	0	
Current Account					227	2	2	Letterpress printing, paper, binding, and distribution	250	2	8	
Subscriptions—I for 1899					1	1	0	Lithographic printing	171	10	11	
„ „ 1900					1	1	0	Drawing and preparing illustrations	201	4	9	
„ „ 1901					15	15	0	Special editing	2	2	0	
„ „ 1902					147	7	0	Secretary's honorarium	52	10	0	
„ „ 1903					206	6	0	Postage and stationery	7	3	6	
„ „ 1904					2	2	0	Fire Insurance	0	15	0	
„ „ 1905					1	1	0	Bank charges and discounts	0	7	6	
—								Balance at Bank—				
373								On Deposit	300	0	0	
Carriage paid by Foreign Members					0	16	1	Current Account	182	4	4	
Sale to a Member					2	7	3					
Sales by Messrs. Dulau & Co.					101	0	7					
Interest					33	17	7					
					<u>£1656</u>		16	8	<u>£1656</u>		16	8

Examined, with vouchers produced, and found correct.

JOHN HOPKINSON,
AUBREY STRAHAN,
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April 20th, 1903.

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CORRECTED TO 1ST NOVEMBER, 1903.

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CATALOGUE OF THE CONTENTS OF THE ANNUAL VOLUMES

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY.

- Vol. I. Issued for the Year 1847 The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood (pp. i—xii, 1—208, pls. i—xxi, and title-page).
- „ II. „ 1848 { The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell (pp. 1—76, pls. i—xxviii, viii A, x A, xiii A, xvi A, xviii A, xix*, xix B, xix C, xix D).
The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards (pp. 1—56, pls. i—ix).
- „ III.¹ „ 1849 { The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones (pp. 1—40, pls. i—vii).
The Permian Fossils, by Prof. Wm. King (pp. i—xxxviii, 1—258, pls. i—xxviii*).
The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen (pp. 1—68, pls. xxix, i—xvi, ii A).
The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime (pp. i—lxxxv, 1—72, pls. i—xi).
- „ IV. „ 1850 { The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood (pp. 1—150, pls. i—xii).
The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett (pp. i—viii, 1—130, pls. i—xv).
The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson (pp. 1—64, pls. i—xiii).
- „ V. „ 1851 { The Reptilia of the Cretaceous Formations, by Prof. Owen (pp. 1—118, pls. i—xxxvii, vii A, ix A).
The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime (pp. 73—146, pls. xii—xxx).
The Fossil Lepididæ, by Mr. Charles Darwin (pp. i—vi, 1—88, pls. i—v).
- „ VI. „ 1852 { The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime (pp. 147—210, pls. xxxi—xlvi).
The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson (pp. 1—23, pls. i, ii).
The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson (pp. 1—54, pls. i—v).
The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson (pp. 65—100, pls. xiv—xviii).
The Eocene Mollusca, Part II, Palmonata, by Mr. F. E. Edwards (pp. 57—122, pls. x—xv).
The Echinoderms of the Crag, London Clay, &c., by Prof. E. Forbes (pp. i—viii, 1—36, pls. i—iv, and title-page).
- „ VII. „ 1853 { The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime (pp. 211—244, pls. xlvii—lvi).
The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson (pp. 1—136, pls. i—ix).
The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe (pp. 1—26, pls. i—x).
The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett (pp. 1—80, pls. i—viii).
The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood (pp. 151—216, pls. xiii—xx).
The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen (pp. 1—12, pls. i—ix).

¹ The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils'; the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF VOLUMES—Continued.

Vol. VIII. ¹	Issued for the Year 1854	{	The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous (pp. 55—117, pls. vi—xii), with Appendix and Index to Vol. I, by Mr. Davidson (pp. 1—30, pl. A).
			The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen (pp. 1—54, pls. i—xix, xvi A).
		{	The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett (pp. 81—147, pls. ix—xv).
			The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime (pp. 245—322, pls. lvii—lxxii).
		{	The Fossil Balanidae and Verrucidae, by Mr. Charles Darwin (pp. 1—44, pls. i, ii).
			The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe (pp. 27—36, pls. xi—xvi).
		{	The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards (pp. 123—180, pls. xvi—xxiii).
			The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood (pp. 217—342, pls. xxi—xxxi).
.. IX. ²	.. 1855	{	The Reptilia of the Wealden Formations, Part III, by Prof. Owen (pp. 1—26, pls. i—xii).
			The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards (pp. 181—240, pls. xxiv—xxvii).
		{	The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe (pp. 37—68, pls. xvii—xxvii).
			The Tertiary Entomotrachea, by Mr. T. R. Jones (pp. i—xii, 1—68, pls. i—vi).
		{	The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright (pp. v—x, 1—154, pls. i—x).
			The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright (pp. 155—302, pls. xi—xxii).
.. X.	.. 1856	{	The Fossil Crustacea, Part I, London Clay, by Prof. Bell (pp. i—viii, 1—44, pls. i—xi).
			The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson (pp. 1—51, pls. i—iv).
		{	The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson (pp. 1—48, pls. i—viii).
			The Reptilia of the Wealden Formations, by Prof. Owen, Part IV (pp. 8—26, pls. iv—xi), and Supplement No. 1 (pp. 1—7, pls. i—iii).
		{	The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen (pp. 77—79, pls. xxviii A, xxviii B).
			The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright (pp. 303—390, pls. xxiii—xxxvi).
.. XI.	.. 1857	{	The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson (pp. 49—80, pls. ix—xvi).
			The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen (pp. 1—19, pls. i—iv).
		{	The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen (pp. 20—44, pls. v—xii).
			The Polyzoa of the Crag, by Prof. Busk (pp. i—xiv, 1—136, pls. i—xxii).
		{	The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright (pp. 391—468, pls. xxxvii—xlvi).
			The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards (pp. 241—330, pls. xxviii—xxxiii).
.. XII.	.. 1858	{	The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen (pp. 27—30, pl. vii, pp. 1—25, pls. i—vi).
			The Reptilia of the Purbeck Limestones, by Prof. Owen (pp. 31—39, pl. viii).
		{	The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous by Mr. Davidson (pp. 81—120, pls. xvii—xxvi).
			The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson (pp. 121—210, pls. xxvii—xlvi).
		{	The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen (pp. 1—14, pls. i—vi).
			The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen (pp. 15, 16, pl. vii).
.. XIII.	.. 1859	{	The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood (pp. 1—74, pls. i—xiii).

¹ This Volume is marked on the outside 1855.² This Volume is marked on the outside 1856.

CATALOGUE OF VOLUMES—Continued.

Vol. XIV.	Issued for the Year 1860	{	The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson (pp. 211—280, pls. xlviii—lv).
			The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen (pp. 1—26, pls. i—xi).
			The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen (pp. 27, 28, pl. xii).
			The Fossil Estheria, by Prof. Rupert Jones (pp. i—x, 1—134, pls. i—v).
„ XV.	„ 1861	{	The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell (pp. i—vii, 1—40, pls. i—xi).
			The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright (pp. 1—130, pls. i—x, x A, xi, xii).
			Supplement to the Great Oolite Mollusca, by Dr. Lycett (pp. 1—129, pls. xxxi—xlvi).
			The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright (pp. 1—64, pls. i—iii, iii A, iv—vii, vii A, viii, xi).
„ XVI.	„ 1862	{	The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter (pp. 1—80, pls. i—vi).
			The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson (pp. 1—56, pls. i—ix).
			The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood (pp. 75—136, pls. xiv—xx).
			The Reptilia of the Cretaceous and Wealden Formations (Supplement, No. 4), by Prof. Owen (pp. 1—18, pls. i—ix).
„ XVII.	„ 1863	{	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter (pp. 81—128, pls. vii—xiv).
			The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson (pp. 57—131, pls. x—xx).
			The Belemnitidae, Part I, Introduction, by Prof. Phillips (pp. 1—28).
			The Reptilia of the Liassic Formations, Part I, by Prof. Owen (pp. 1—40, pls. i—xvi).
„ XVIII.	„ 1864	{	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright (131—154, pls. xiii—xviii).
			The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter (pp. 129—176, pls. xv—xxv).
			The Belemnitidae, Part II, Liassic Belemnites, by Prof. Phillips (pp. 29—52, pls. i—vii).
			The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. i—1, 1—28, pls. i—v).
„ XIX. ¹	„ 1865	{	Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
			The Crag Foraminifera, Part I, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady (pp. i—vi, 1—72, pls. i—iv).
			Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan (pp. i—iii, 1—66, pls. i—x).
			The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward (pp. 1—44, pls. i—ix).
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„ LIII. ¹	„ 1898	{	The Carboniferous Cephalopoda of Ireland, Part II, by Dr. A. H. Foord (pp. 23—48, pls. viii—xvii).
			The Devonian Fauna of the South of England, Vol. III, Part III, by the Rev. G. F. Whidborne (pp. 179—236, pls. xxii—xxxviii).

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			The Cretaceous Lamellibranchia, Part I, by Mr. H. Woods (pp. 1—72, pls. i—xiv).
			The Carboniferous Lamellibranchiata, Part IV, by Dr. W. Hind (pp. 277—360, pls. xxvi—xxxix).
			The Inferior Oolite Ammonites, Part XI, by Mr. S. S. Buckman (pp. xxxiii—lxiv, pls. v—xiv).
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			The Carboniferous Cephalopoda of Ireland, Part III, by Dr. A. H. Foord (pp. 49—126, pls. xviii—xxxii).
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„ LVII. ¹	„ 1903	{	The Cretaceous Lamellibranchia, Part IV, by Mr. H. Woods (pp. 145—196, pls. xxvii—xxxviii).
			British Graptolites, Part I, No. 2, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. i—xxviii, 55—94, pls. v—xiii).
			The Fishes of the English Chalk, Part II, by Dr. A. Smith Woodward (pp. 57—96, pls. xiv—xx).
			The Cretaceous Lamellibranchia, Part V, by Mr. H. Woods (pp. i—xliii, 197—232, pls. xxxix—xlii), Title-page and Index for Vol. I.
„ LVIII. ¹	„ 1904	{	The Carboniferous Lamellibranchiata, Vol. II, Part II, by Dr. W. Hind (pp. 35—124, pls. vii—xxi).
			The Carboniferous Cephalopoda of Ireland, Part V, by Dr. A. H. Foord (pp. 147—234, pls. xl—xlix), Title-page and Index.
			The Lower Palæozoic Trilobites of Girvan, Part I, by Mr. F. R. Cowper Reed (pp. 1—48, pls. i—vi).
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Dates of Issue of the Annual Volumes of the Palæontographical Society.

Volume	I	for	1847	was	issued	to	the	Members,	March, 1848.
"	II	"	1848	"	"	"	"	"	July, 1849.
"	III	"	1849	"	"	"	"	"	August, 1850.
"	IV	"	1850	"	"	"	"	"	June, 1851.
"	V	"	1851	"	"	"	"	"	June, 1851.
"	VI	"	1852	"	"	"	"	"	August, 1852.
"	VII	"	1853	"	"	"	"	"	December, 1853.
"	VIII	"	1854	"	"	"	"	"	May, 1855.
"	IX	"	1855	"	"	"	"	"	February, 1857.
"	X	"	1856	"	"	"	"	"	April, 1858.
"	XI	"	1857	"	"	"	"	"	November, 1859.
"	XII	"	1858	"	"	"	"	"	March, 1861.
"	XIII	"	1859	"	"	"	"	"	December, 1861.
"	XIV	"	1860	"	"	"	"	"	May, 1863.
"	XV	"	1861	"	"	"	"	"	May, 1863.
"	XVI	"	1862	"	"	"	"	"	August, 1864.
"	XVII	"	1863	"	"	"	"	"	June, 1865.
"	XVIII	"	1864	"	"	"	"	"	April, 1866.
"	XIX	"	1865	"	"	"	"	"	December, 1866.
"	XX	"	1866	"	"	"	"	"	June, 1867.
"	XXI	"	1867	"	"	"	"	"	June, 1868.
"	XXII	"	1868	"	"	"	"	"	February, 1869.
"	XXIII	"	1869	"	"	"	"	"	January, 1870.
"	XXIV	"	1870	"	"	"	"	"	January, 1871.
"	XXV	"	1871	"	"	"	"	"	June, 1872.
"	XXVI	"	1872	"	"	"	"	"	October, 1872.
"	XXVII	"	1873	"	"	"	"	"	February, 1874.
"	XXVIII	"	1874	"	"	"	"	"	July, 1874.
"	XXIX	"	1875	"	"	"	"	"	December, 1875.
"	XXX	"	1876	"	"	"	"	"	December, 1876.
"	XXXI	"	1877	"	"	"	"	"	February, 1877.
"	XXXII	"	1878	"	"	"	"	"	March, 1878.
"	XXXIII	"	1879	"	"	"	"	"	May, 1879.
"	XXXIV	"	1880	"	"	"	"	"	May, 1880.
"	XXXV	"	1881	"	"	"	"	"	May, 1881.
"	XXXVI	"	1882	"	"	"	"	"	June, 1882.
"	XXXVII	"	1883	"	"	"	"	"	October, 1883.
"	XXXVIII	"	1884	"	"	"	"	"	December, 1884.
"	XXXIX	"	1885	"	"	"	"	"	January, 1886.
"	XL	"	1886	"	"	"	"	"	March, 1887.
"	XLI	"	1887	"	"	"	"	"	January, 1888.
"	XLII	"	1888	"	"	"	"	"	March, 1889.

Volume XLIII	for	1889	was	issued	to	the Members,	March, 1890.
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" XLVII	"	1893	"	"	"	"	December, 1893.
" XLVIII	"	1894	"	"	"	"	November, 1894.
" XLIX	"	1895	"	"	"	"	October, 1895.
" L	"	1896	"	"	"	"	October, 1896.
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" LIV	"	1900	"	"	"	"	December, 1900.
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THE
FOSSIL FISHES
OF THE
ENGLISH CHALK.

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PART II.
PAGES 57—96; PLATES XIV—XX.

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1903.

1. **Enchodus lewesiensis** (Mantell). Plate XIV, figs. 1—8; Text-figure 13.

1822. *Esox lewesiensis*, G. A. Mantell, Foss. S. Downs, p. 237, pl. xxv, fig. 13, pl. xxxiii, figs. 2—4, pl. xli, figs. 1, 2.
 1835–44. *Enchodus halocyon*, L. Agassiz, Poiss. Foss., Feuill., p. 55, and vol. v, pt. i, p. 64, pl. xxv c, figs. 1—6, 8—16 (*non* fig. 7).
 1850. *Enchodus halocyon*, F. Dixon, Geol. Sussex, p. 373, pl. xxx, figs. 20, 27, pl. xxxi, fig. 11.
 1888. *Enchodus lewesiensis*, A. S. Woodward, Proc. Geol. Assoc., vol. x, p. 315 (*in part*), pl. i, fig. 5 (*non* fig. 6).
 1901. *Enchodus lewesiensis*, A. S. Woodward, Catal. Foss. Fishes B.M., pt. iv, p. 191, pl. xi, fig. 1.
 — *Enchodus annectens*, A. S. Woodward, *ibid.*, p. 195, pl. xi, figs. 4, 5.

Type.—Imperfect mandible from one of the Turonian zones; British Museum.

Specific Characters.—The type species, with the mandible sometimes attaining a length of 10 cm. The sides of the cranial roof and the outer face of the mandible ornamented with numerous and closely-arranged sharp ridges, mostly radiating and each bearing a series of small tubercles; these ridges on the dentary bone radiating from the symphysis, on the articulo-angular bone radiating from the mandibular articulation. Palatine bone only slightly produced forwards as a short cylindrical extension in advance of the ethmoid articulation, and the long slender tooth, antero-posteriorly compressed, fixed at its extremity nearly at right angles to the long axis of the bone; the outer face of the premaxilla sparsely ridged, with a slight tubercular ornament; dentary rapidly contracting almost to a point at the symphysis, where it exhibits about three large irregular descending processes; the mandibular ramus considerably deepened behind, its maximum depth nearly equalling one third of its total length; about six large mandibular teeth, all both slender and little curved, the foremost twice as large as any of the others. Teeth much compressed, and some delicately striated, none conspicuously serrated on the edges. Operculum nearly two-thirds as broad as deep, marked by numerous sharp, radiating, tuberculated ridges; suboperculum triangular and nearly equilateral.

Description of Specimens.—The type specimen of this species is an imperfect mandible probably from a Turonian zone near Lewes, described and figured by Mantell under the name of *Esox lewesiensis*. The hinder portion of its left dentary exhibits the characteristic external ornament, and enough of the jaw is preserved to indicate approximately its proportions; but the fossil is very imperfect, the symphysis being broken away in front of the large anterior teeth, and the outer lamina of the dentary being entirely removed, except for the short space already mentioned on the left side. The other three imperfect mandibles referred by Agassiz to the same species under the new name of *Enchodus halocyon* (*op. cit.*, vol. v, pt. i, p. 64, pl. xxv c, figs. 2—5) are evidently of the same form; while

nearly all the other fragments ascribed to it by Agassiz are doubtless correctly determined. There seems, however, to be doubt about the small jaw figured *loc. cit.*, pl. xxv c, fig. 7, which is probably an imperfect dentary of *Tomognathus*; also perhaps about the two palatine bones, figured upside down *loc. cit.*, pl. xxv c, figs. 9, 10, which are imperfectly preserved and may belong to another species of *Enchodus*.

The skull is associated with the typical form of mandible in several known specimens, and is well displayed both in the original of Pl. XIV, fig. 1, and in a smaller specimen in the British Museum (no. P. 5415) already figured in Proc. Geol. Assoc., vol. x, pl. i, fig. 5. There is also an isolated imperfect cranium in the Beekes Collection (B. M. no. P. 6461) evidently of the same form. The maximum depth of the head seems to have been nearly equal to its length; and it is much laterally compressed. The cranium closely resembles that of *Cimolichthys*, but is more laterally compressed and deeper in its hinder part. The small supra-occipital bears the usual posterior crest (Pl. XIV, fig. 1a, *socc.*; also seen in B. M. no. 4071); and the epiotics form the narrow, unornamented, upper rim of the occiput. The parietals are diminutive, but seem to have just entered the ornamented part of the cranial roof, as in *Halec* (Pl. XIII, fig. 4, *pa.*). The ordinary radiating ridges on the frontal region (*fr.*) are very finely tuberculated, those radiating over the postorbital region being fewest and most sparse, those directed outwards over the supraorbital flange the finest and most crowded. The median frontal depression is deep; and its flattened floor, both in the original of Pl. XIV, fig. 1, and in another small specimen (B. M. no. P. 5415), is marked with low tubercles arranged along the radiating lines of growth of the bones. The mesethmoid must have been very short, but it has not hitherto been observed.

The orbit is relatively larger than that of *Eurypholis boissieri* (Text-fig. 12, p. 56) and must have been completely bordered behind and below with a narrow ring of circumorbital plates. One of the hinder plates is partly shown in Pl. XIV, fig. 1, *co.* It is deeper than broad, traversed by a large vertical slime-canal, and ornamented with radiating rows of tubercles. Part of one of the lower plates remains in B. M. no. P. 5415, exhibiting traces of a similarly large slime-canal, with a tuberculated upper rim and a serrated lower edge. The antorbital (*ao.*) is shown in the same specimens. Its deepest portion in front is marked with a few thin but prominent ridges, all finely tuberculated, which radiate downwards from a point situated antero-superiorly. Its hinder portion forms a long and narrow extension beneath the orbit. Its lower border is crimped and serrated.

The mandibular suspensorium is vertical, so that the quadrate articulation is directly beneath the occiput. In one specimen figured by Agassiz (*loc. cit.*, fig. 2), the quadrate exhibits its posterior notch for the reception of a small symplectic. The metapterygoid (*mp.*) is a relatively large and thin, nearly triangular lamina. The entopterygoid (Pl. XIV, figs. 1, 2, *enpt.*) is also a very thin lamina, so transparent

that when seen from the outer face, as in the specimens figured, radiating rows of minute teeth can be observed on its inner or oral face. This plate is elongate-triangular in shape, deepest behind and tapering in front. The ectopterygoid (fig. 2, *ecpt.*) is a stouter, long and narrow lamina, in a plane sloping downwards and outwards to its somewhat thickened lower border. It tapers at both ends and its deepest portion is just behind the palatine element, which it underlaps. A fragment of its anterior end with part of the overlapping palatine is shown, upside down, from the inner face, by Agassiz, *loc. cit.*, pl. xxv c, fig. 6, and is re-drawn in Pl. XIV, fig. 3. The complete bone bears a single series of five or six widely-spaced teeth, which are lanceolate, much laterally compressed and sharply pointed, with the

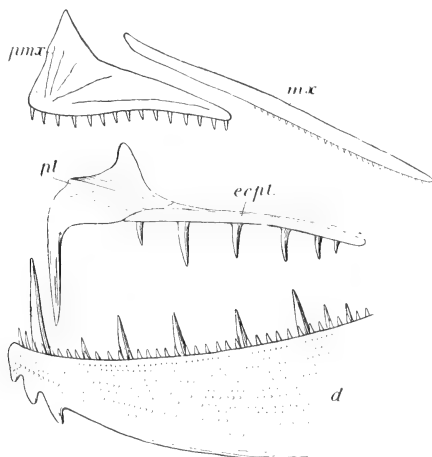


FIG. 13. *Enchodus levisiensis* (Mantell); diagram of jaws, left side, outer aspect. — English Chalk. *d.*, dentary; *ecpt.*, ectopterygoid (somewhat in perspective); *mx.*, maxilla; *pl.*, palatine; *pmx.*, premaxilla.

anterior and posterior edges acute, and the lateral faces marked by delicate longitudinal striae. These teeth are scarcely recurved, but their anterior edge exhibits a slightly sigmoidal flexure, while their posterior edge is straighter. Their spacing, like that of the mandibular teeth, varies in different individuals; for each successional tooth arises either in front of or behind the corresponding functional tooth, as already described in *Vimolichthys* (p. 46). Again, as in the mandible, there is some variation in the relative size of the teeth, even on the two sides of the same jaw. The foremost tooth (fig. 3, *a.*), on the extension beneath the palatine, is of moderate size, while the second tooth (*b.*) is the largest of the series. The three or four posterior teeth, shown by Agassiz, *loc. cit.*, in his figs. 1, 2, rapidly decrease in size backwards. The palatine (fig. 2, *pl.*, figs. 4—6) is a remarkably thick and tumid bone, quite smooth, and bearing only a single large tooth at its anterior end. It occupies

nearly one-quarter of the oral border of the palato-pterygoid arcade, and its hinder half overlaps the ectopterygoid. Its large inner facette for articulation with the cranium extends far forwards, and at the anterior end of this articulation the depth of the bone somewhat exceeds one-third of its total length. Its outer face (fig. 4) is marked with an oblique, rounded depression just below the upper edge of the articulation. The rounded anterior portion of the bone bearing the tooth is very short, but as the extreme end is formed by the bony base of the tooth itself, the exact shape doubtless varies according to the presence of the anterior or the posterior tooth of the two which are alternately in use. The palatine tooth itself is straight and lanceolate, and its length about equals that of the bone which bears it. As shown in transverse section (fig. 6), both its faces are convex, the antero-external face regularly so, the postero-internal face unsymmetrically bulging inwards. The outer view of the tooth (fig. 4) thus shows the one face bounded by the sharp edges; while the inner view (fig. 5) shows parts of both convex faces divided by the inner sharp edge. Both these faces are marked with delicate longitudinal striae, which are especially conspicuous in the original of fig. 5. The maxilla (fig. 1, *mx.*) is a very slender bar of bone, not expanded at either end, but marked in its hinder portion by two or three finely-tuberculated longitudinal ridges. Its anterior half is excluded from the gape by the premaxilla, while its posterior half distinctly enters the oral border and seems to have borne minute teeth (B. M. no. P. 5415). The premaxilla is obscured in the original of fig. 1 by matrix and the displaced antorbital plate; but it is shown from the inner aspect by Agassiz, *loc. cit.*, fig. 1 (right lower corner of specimen), while its outer face is exposed in B. M. no. P. 5415, which is figured in Proc. Geol. Assoc., vol. x, pl. i, fig. 5. It is an irregularly triangular lamina of bone, deepest in front and tapering to a point behind. It seems to have been about twice as long as deep, and its oral margin exhibits a slightly sinuous curve, turning upwards in front. It bears a single series of small conical teeth, which are well spaced and nearly uniform in size, with a tendency towards backward inclination. Its outer face is marked with a few ridges radiating from a point situated antero-inferiorly, and there are sometimes traces of a tubercular ornament. Where the premaxilla curves inwards in front to meet its fellow of the opposite side, the outer face of the bone is impressed with a deep, vertically extended pit. This is well shown on a fragment in B. M. no. P. 6159 *a*. The mandible is satisfactorily seen from the outer aspect in fig. 1, and its maximum depth in the coronoid region is shown to equal about one third of its total length. The articulo-angular bone (*ag.*) is relatively large, extending along half the length of the jaw. Its outer face is ornamented with finely tuberculated ridges, which radiate forwards and upwards from the mandibular articulation and are fewest on the coronoid portion. The dentary (*dl.*) tapers rapidly forwards to an almost pointed symphysis, imperfect in fig. 1, but well seen in a fragmentary detached specimen which is represented in fig. 7. Below the attenuated symphysis

there are three peculiar, downwardly-directed, processes of bone. The complete dentary consists of an outer and an inner lamina, firmly united at the upper and lower edges, and enclosing a space for the large meckelian cartilage. The inner lamina is shown in the specimen represented by Agassiz, *loc. cit.*, fig. 4, and is excavated behind. The outer lamina is slightly incurved below and is ornamented on its exposed face with closely-arranged and finely-tuberculated ridges, which radiate backwards from the symphysis. The teeth on the dentary bone are arranged in two rows. On its extreme outer border there is a regular, close series of very small and slender conical teeth, which are nearly uniform in size but slightly largest at the end of the symphysis. These teeth are often wanting in the imperfect fossils, but most of them are indicated in fig. 1, and two or three are preserved at the anterior end of the dentary shown in fig. 7. The inner row comprises only six to eight widely-spaced, slender, lanceolate teeth, which have sharp anterior and posterior edges and delicately striated faces. Some of them exhibit a slightly sigmoidal anterior edge which imparts to them a gently recurved appearance. The foremost tooth is much the largest, at least twice as long as any of the others; and it is seen with its replacing tooth (*x.*) in fig. 7. The second tooth and the hindmost tooth are the smallest of the series. The general aspect of the jaws is diagrammatically represented in Text-fig. 13, p. 59.

The preoperculum (figs. 1, 8, *pop.*) is deep and narrow, without a lower limb, but tapering to a point above and expanding into a small triangular lamina below. The vertical groove on its outer face for the slime-canal is deep and large; the ridge of bone in front of this groove is tuberculated; while the narrow wing behind and below it is ornamented with short radiating ridges which terminate at the posterior and inferior edge in crenulations. The operculum is more than half as wide as deep, and has the peculiarly rounded form indicated in fig. 1, *op.* Two imperfect examples of this bone are described by Agassiz as scales, *loc. cit.*, p. 65, pl. xxv c, figs. 14, 15. Its external face is ornamented with a close series of finely-tuberculated ridges, which radiate from the rather low point of suspension; and between some of these ridges there are short intercalated rows of tubercles at the margin of the bone. The inner face of the operculum is strengthened by a small ridge extending horizontally backwards from the point of suspension. The suboperculum (*sop.*) is partly obscured in fig. 1, but better seen in fig. 8. Its outline is nearly that of an equilateral triangle, and its outer face is ornamented with finely-tuberculated ridges which radiate downwards and backwards from its antero-superior angle. As on the operculum, there are short intercalated ridges or rows of tubercles between the distal ends of the main ridges. The branchiostegal rays (fig. 1, *br.*) are very slender, as especially well shown in B. M. no. 25921.

Very few vertebrae of this species are known, but the abdominal series, followed by three or four anterior caudals, is represented in fig. 1. The centra in

this region are much-constricted, delicate cylinders, scarcely longer than deep, without transverse processes, and only strengthened by a few slight longitudinal ridges. The base of each neural arch is a low lamina extending nearly from end to end of the centrum. In the anterior abdominal vertebrae this lamina rises into a pair of spinous processes, which seem to bear a sigmoidally-bent, broad, neural spine (*c.*). More posteriorly there is only a slender simple spine fixed to the middle or hinder half of the laminar arch. The ribs are antero-posteriorly compressed, and each articulates directly with the anterior end of the centrum to which it belongs. Probably sixteen centra bear true ribs; but the centrum marked *c.* in fig. 1 has a fixed hæmal arch with spine and is undoubtedly referable to the caudal series.

The left post-temporal is partly shown in fig. 1 *a* (*ptt.*) and clearly impinges on the supraoccipital. It is a thin lamina, longer than broad, externally ornamented with a few tuberculated radiating ridges. Only insignificant fragments of the appendicular skeleton are known.

Horizons and Localities.—Zones of *Holaster subglobosus* to *Terebratulina gracilis*: neighbourhood of Lewes, Sussex. Zone of *Holaster subglobosus*: Burham, Kent (G. E. Dibley); Glynde and Clayton, Sussex. Zone of *Micraster coranguinum*: Grays, Essex; Bromley, Kent. Probably Senonian zones: Brighton; Shalford, near Guildford.

2. *Enchodus pulchellus*, A. S. Woodward. Plate XIV, figs. 9—11; Text-figure 14.

1888. *Enchodus lewesiensis*, A. S. Woodward, Proc. Geol. Assoc., vol. x, pl. i, fig. 6 (*errore*).

1901. *Enchodus pulchellus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 193, pl. xi, figs. 2, 3.

Type.—Imperfect head probably from a Cenomanian zone; British Museum.

Specific Characters.—A species usually about as large as *E. lewesiensis*, with more slender mandible and more finely ornamented external bones; very few of the ornamental tubercles raised on ridges. Palatine bone produced considerably forwards in advance of the ethmoid articulation; maximum depth of mandibular ramus equalling about one quarter of its total length; more than six large mandibular teeth, all both slender and little curved. Maximum width of operculum almost or quite equalling its depth; suboperculum triangular, but about twice as wide as deep.

Description of Specimens.—The type specimen in the Egerton Collection (Pl. XIV, fig. 9) shows the left lateral aspect of the head, imperfect in front. Part of the ornamented left side of the cranium is preserved, while the characteristic mandible and opercular apparatus are exposed. The palatine bone is covered by

the premaxilla, but the teeth both of the palato-pterygoid arcade and of the dentary are well displayed.

As shown by this specimen, the tubercles on the outer side of the frontal region are disposed along the usual radiating ridges. A fragment of the parasphenoid (*pas.*) indicates that the basicranial axis was parallel with the hinder part of the cranial roof. Traces of the antorbital cheek-plate (*ao.*) show the tuberculated radiating ridges already observed in *E. lewesiensis*. The hyomandibular (*hm.*) is a rather wide lamina of bone, its upper articular border extending from end to end of the otic region. The quadrate is notched to receive the symplectic, as especially well seen in B. M. no. 49811. The palato-pterygoid arcade is very characteristic of the species, and a restored outline-sketch of it is given in Text-fig. 14. The ectopterygoid and its dentition are for the most part exposed in figs. 9, 10 (*ecpt.*), but are still better seen in B. M. no. P. 5416, which is used as the basis of Text-fig. 14. There are six large, slender ectopterygoid teeth, of which the foremost,

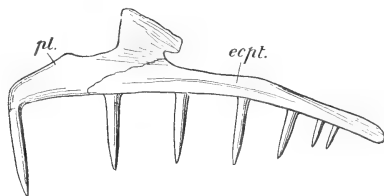


FIG. 14. *Enchodus pulchellus*, A. S. Woodward: left palato-pterygoid arcade, outer aspect.—English Chalk. *ecpt.*, ectopterygoid; *pl.*, palatine.

inserted beneath the palatine articulation, is the largest, while the others decrease in size backwards. The size and relative position of these teeth vary as in the other species; but all are much laterally compressed, very delicately striated, and scarcely if at all recurved. On the inner face of the ectopterygoid, just above the three hindmost teeth, there are three or four longitudinal rows of very small tubercular teeth. As represented in Text-fig. 14 the palatine bone (*pl.*) forms somewhat less than a quarter of the oral border of the palato-pterygoid arcade; but half of this element extends backwards above the ectopterygoid, and its inner facette for articulation with the ethmoid seems to have been restricted to this hinder half. The terminal palatine tooth (figs. 9, 10, *pl.*) seems to have closely resembled that of *E. lewesiensis*, though apparently shorter when compared with the length of its supporting bone. The isolated large palatine shown of the natural size in figs. 11, 11*a*, is provisionally associated with this species, since its shape appears to be identical with that of B. M. no. P. 5416. It is interesting as showing on the inner face (fig. 11*a*) the rather complicated articular facette for union with the ethmoid region. Its anterior portion is much produced in front of this

facette, and its outer face (fig. 11) lacks the shallow depression characteristic of *E. lewesiensis*. Its postero-superior angle is slightly incomplete. The premaxilla (fig. 9, *pma.*) is longer in proportion to its depth than in the latter species, and the radiating ridges on its outer face are strongly tuberculated. The comparatively slender form of the mandible is indicated by figs. 9, 10, although in both these specimens the symphysis is wanting. The articulo-angular (*ag.*) is exposed along about half the length of the ramus, and its outer face is completely covered with fine tuberculations, which are not fixed on ridges although they sometimes appear to be arranged in radiating rows. The dentary (*d.*) is similarly ornamented, and the teeth of its inner spaced series are both more numerous and relatively smaller than in *E. lewesiensis*.

As in the last-mentioned species, the preoperculum (figs. 9, 10, *pop.*) is slightly expanded at the lower end. The operculum (*op.*) has a very characteristic shape and ornamentation. Its radiating lines of tubercles are much finer and more numerous than in *E. lewesiensis*, and the concentric lines of growth of the bone are especially conspicuous. The horizontal ridge on the inner face of the operculum is very stout (B. M. no. P. 5416). The suboperculum, though imperfect in the originals of figs. 9, 10 (*sop.*), is evidently at least twice as wide as its maximum depth; and its very fine tubercular ornament tends to range in lines from the upper to the postero-inferior border.

The trunk of this species is unknown, but an anterior scute of the lateral line is shown from the inner aspect behind the operculum in fig. 10 (*s.*). This scute is slightly deeper than broad, rhomboidal in shape, deeply cleft behind and pierced in front by the large slime-canal. It closely resembles the scutes of the lateral line in *Eurypholis* (Text-fig. 12, p. 56), and is ornamented on the outer face with radiating series of small tubercles.

Horizons and Localities.—Probably zones of *Holaster subglobosus* to *Terebratulina gracilis*: neighbourhood of Lewes, Sussex; neighbourhood of Burham, Kent. Zone of *Holaster subglobosus*: Betchworth, Surrey (W. P. D. Stebbing). Undetermined zone: Dover, Kent.

Family DERCETIDÆ.

A family of Cretaceous fishes apparently related to the surviving Halosauridæ (Text-fig. 17, p. 75) and Notacanthidæ. Mandibular suspensorium vertical or inclined backwards, and gape of mouth very wide. Teeth small and numerous, conical and slender. Opercular apparatus complete, with few slender branchiostegal rays, but no gular plate. Ordinary scales small or wanting, but two or more continuous paired series of enlarged scutes along the flank; no median dorsal or ventral scutes.

Genus **DERCETIS**, Agassiz.

Dercetis, L. Agassiz, Neues Jahrb., 1834, p. 389.

Generic Characters.—Vertebrae between 50 and 60 in number. Dorsal fin occupying the greater part of the back, and anal fin opposed to its hinder portion; caudal fin forked. Dermal scutes considerably expanded, and the adjoining longitudinal series often in contact; a paired series along the dorsal and ventral borders, and another along the lateral line; no intermediate squamation.

Type Species.—*Dercetis scutatus* (L. Agassiz, Neues Jahrb., 1834, p. 390, and A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, 1901, p. 172), from the Upper Cretaceous of Baumberg, Westphalia.

Remarks.—The two species from the English Chalk provisionally referred to this genus, are only known by fragmentary remains which are insufficient for exact generic determination.

1. ***Dercetis latiscutatus***, sp. nov. Plate XV, fig. 1.

Type.—Middle portion of trunk from a Turonian zone; Willett Collection, Brighton Museum.

Specific Characters.—Dermal scutes short and broad, angularly bent at the middle, which is not much produced forwards. The outer face of the scutes ornamented in front with tubercles, which are sometimes arranged in radiating rows; behind with reticulating ridges, which tend towards a direction at right angles to the posterior border. Dorso-lateral scutes of the middle of the trunk about equal in size to those of the lateral line, with which they are in contact and interdigitate.

Description of Specimens.—The type specimen comprises a fragment of the head and remains of the middle portion of the trunk (Pl. XV, fig. 1). It is insufficient to determine the exact proportions of the fish.

The head, as indicated by the type and by a smaller specimen in the British Museum (no. P. 3847) evidently of the same species, must have been closely similar to that of *Leptotrachelus elongatus* (described below, p. 70). Its inter-orbital region seems to have been slightly wider than in the latter species, and the antero-lateral portions of the frontal bones are ornamented with a few ridges which radiate forwards. In B. M. no. P. 3847 there are the usual slender, clustered teeth.

The dermal scutes encircling the middle of the trunk clearly form a continuous

ring in the type specimen (fig. 1), those of the dorso-lateral and ventro-lateral series interdigitating with those of the lateral line. All are very broad in proportion to their length, and conspicuously ornamented. Each dorso-lateral scute (fig. 1, *d*., and fig. 1*a*) has the shorter arm directed dorsally, and this is truncated at the end to meet its fellow of the opposite side in the median line of the back. The sharp longitudinal ridge at the angulation of the scute ends in a sharp point in front, while a small, backwardly-curved, uncinat spine is fixed upon its hinder half (broken away in most cases, as in fig. 1*a*, but seen in side view towards the hinder end of the fossil, fig. 1, *d'*). The descending or lateral arm of the scute tapers to a point. Near to, and almost parallel with, the hinder border of the scute, there is a strengthening ridge or angulation. The outer face is for the most part ornamented with coarse tuberculations, which are sometimes arranged in rows radiating forwards. Posteriorly these tubercles pass into low, reticulating ridges, of which the principal direction is at right-angles to the hinder border. The scutes of the lateral line (*l*.) closely resemble those of the dorso-lateral series in size, shape, and ornamentation; but both their arms are tapering, and they seem to lack the uncinat spine on their angulation. The ventro-lateral scutes appear to be similar to those of the dorso-lateral series and bear the uncinat spine; but they are only known by fragments (*v*.).

Traces of the dorsal fin-rays (*f*.) are seen in the middle line of the back of the type specimen between the paired series of scutes.

Horizons and Localities.—Probably zone of *Terebratulina gracilis*: Glynde, Sussex. Specimen in the Emmiskillen Collection (B. M. no. P. 3847) labelled "Chalk, Kent," doubtless from a Turonian zone.

2. ***Dercetis maximus***, sp. nov. Plate XV, fig. 2.

Type.—Fragmentary head and trunk from zone of *Micraster coranquinum*; British Museum.

Specific Characters.—A comparatively large species, the head attaining a length of at least 12 cm. External bones ornamented with very fine tuberculated ridges. Dermal scutes of middle of trunk broad, the three longitudinal series in contact and interdigitating; their outer face ornamented with coarse tuberculations, variously disposed in lines. Dorso-lateral scutes largest, broader than long; scutes of lateral line about as long as broad, scarcely more than half as broad as the dorso-laterals; ventro-lateral scutes longer than broad, of medium size.

Description of Specimen.—This species is known only by the type specimen, of which portions are represented in Pl. XV, figs. 2, 2*a*—*c*. The tip of the snout is lost and only portions of the head are exposed from the left side. The remains of the trunk are also very fragmentary.

The head (fig. 2) exhibits the usual attenuated form, and its total length must have equalled about three times its maximum depth at the occiput. The short postorbital region of the cranium is indicated; and the left supraorbital flange of the frontal (*fr.*) is seen from below, its edge bearing traces of the fine external tubercular ornament. The very slender parasphenoid (*pas.*) is partly preserved in its natural position. The remains of the hyomandibular, metapterygoid (*mpt.*), and quadrate (*qu.*) are thin, laminar bones; while the anterior edge of the preoperculum seems to have been straight and vertical. The bone of the mandible is much flaked, but on the right side its outer face is shown to be ornamented by very fine and close tuberculated ridges, which are disposed longitudinally. The oral border of the left dentary (*d.*) is impressed with a regular series of shallow sockets for small teeth; and traces of the characteristic teeth themselves are scattered through the chalk above. The fragments of bone just behind the head are not readily interpreted, but the imperfect left clavicle (*cl.*) is distinguishable.

The vertebral centra of the abdominal region are much-constricted cylinders, their maximum depth exceeding half their length. They are all unsatisfactorily preserved, and the nature of their arches is uncertain. The two examples marked *vb.* in fig. 2, seem to exhibit the neural arch, which is produced postero-superiorly into a short neural spine, antero-superiorly into a shorter zygapophysial articulation. The imperfect centra further back, represented in fig. 2 *a*, bear along their entire length a laminar process, which terminates at its free edge in sharp digitations: whether this is the transverse process or a neural or haemal arch, cannot be decided.

The dermal scutes encircling the middle of the trunk clearly form a continuous ring. None of them are sharply angulated, and all are remarkable for the coarseness of their tubercular ornament, which can be partly seen from the inner face through the frequently translucent bone. Some of these scutes are represented from the inner aspect in figs. 2 *b*, 2 *c*. The anterior and posterior borders of each dorso-lateral scute (fig. 2 *b*, *d.*) are nearly parallel, and the median angulation ends in a sharp point anteriorly. The two truncated arms of each scute are almost equal in size. The scutes of the lateral line (*l.*) are only about half as wide as those of the dorso-lateral series, and are symmetrically triradiate, with the anterior arm bluntly rounded in front, the other arms sharply truncated. The slime-canal pierces the hinder half, and traverses a groove on the inner face of the anterior half of each scute. Three of the scutes of the ventro-lateral series, immediately behind the expanded pelvic fin-support (*plv.*), are shown from the inner aspect in fig. 2 *c* (*v.*). They are somewhat larger than those of the lateral line, but very similar to the latter in shape, with a more sharply pointed anterior end. Their postero-superior arm is a little longer than their postero-inferior arm.

Horizon and Locality.—Zone of *Micraster coranquinum*: Grays, Essex.

Genus **LEPTOTRACHELUS**, W. von der Marck.*Leptotrachelus*, W. von der Marck, Palæontogr., vol. xi, 1863, p. 59.*Tricinaspis*, E. D. Cope, Bull. U.S. Geol. Surv. Territ., vol. iv, 1878, p. 67.

Generic Characters.—Vertebræ between 60 and 80 in number. Dorsal fin occupying not more than the middle third of the back; pelvic fins opposed to this, but anal fin more remote; caudal fin forked. Most of the dermal scutes triradiate, some narrow heart-shaped, and adjoining longitudinal series scarcely if at all in contact; a paired series along the dorsal and ventral borders, and another along the lateral line; no intermediate squamation.

Type Species.—*Leptotrachelus armatus* (W. von der Marck, Palæontogr., vol. xi, 1863, p. 59, pl. x, fig. 3), from the Upper Cretaceous of Sendenhorst, Westphalia.

Remarks.—The finest known examples of species of this genus have been obtained from the Upper Cretaceous of Sahel Alma, near Beyrout, Syria. Some of them are described in detail in the 'Catal. Foss. Fishes B. M.,' pt. iv, pp. 174—184, and form the basis of the accompanying restored sketch of *L. triqueter* (Text-fig. 15). One specimen in the British Museum (Text-fig. 16) encloses a comparatively large undigested fish, which may be regarded as evidence of a distensible stomach. The remains of the only known species from the English Chalk are important as displaying the osteology of the head.

1. **Leptotrachelus elongatus** (Agassiz). Plate XVI.

1835-44. *Dercetis elongatus*, L. Agassiz, Poiss. Foss., Feuill., p. 55, and vol. ii, pt. ii, p. 258, pl. lxxi a, figs. 1, 2, 5—8 (*non* figs. 3, 4).

1879. *Dercetis elongatus*, W. Davies, Geol. Mag. [2], vol. vi, p. 145.

1888. *Dercetis elongatus*, A. S. Woodward, Proc. Geol. Assoc., vol. x, p. 318, pl. i, fig. 7.

1901. *Leptotrachelus elongatus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 184, pl. xii, fig. 4.

Type.—Imperfect head and trunk, probably from one of the Turonian zones; British Museum.

Specific Characters.—A slender species, probably attaining a length of about 60 cm., but usually smaller. The postorbital region of the skull about as broad as long, this occupying the hinder quarter and the orbit the next quarter of the cranial length; the length of the head with opercular apparatus contained between five and six times in the total length of the fish to the base of the caudal fin.

Family DERCEIDÆ.—Genus **LEPTOTRACHELUS**, W. von der Marek.

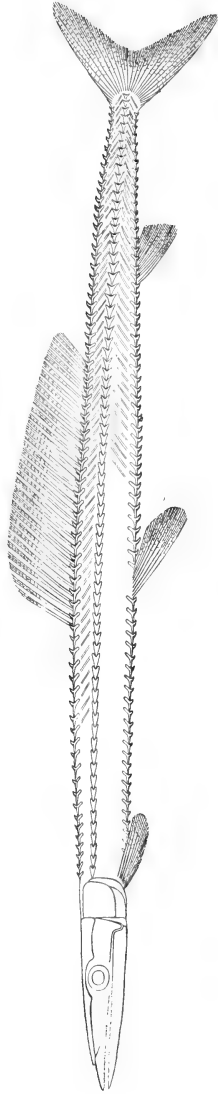


FIG. 15. *Leptotrachelus triquetus*, Fictet; restoration, showing dermal scutes, about one-half nat. size.—Upper Cretaceous; Sahel Alma, Mt. Lebanon.

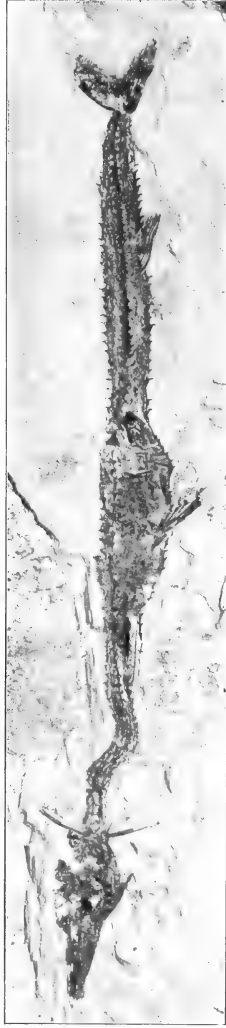


FIG. 16. *Leptotrachelus triquetus*, Fictet; photograph of fossil in limestone, showing a comparatively large fish in its distended stomach, two-thirds nat. size.—Upper Cretaceous; Sahel Alma, Mt. Lebanon. (E. R. Lewis Collection, British Museum no. 49340.)

Anterior abdominal vertebral centra about three times as long as deep, those beyond less elongated, and those in the hinder half of the abdominal region with large transverse processes. Dermal scutes of moderate size and narrow, more or less ornamented with short ridges and spinous tubercles; those on the anterior abdominal region not excessively attenuated; those on the dorsal and ventral borders of the posterior abdominal and caudal regions bearing a slender backwardly directed uncinate spine.

Description of Specimens.—The type specimen in the Mantell Collection (nos. 4132–33) is an imperfect small fish preserved in the counterpart halves of a block of chalk from the neighbourhood of Lewes (Pl. XVI, figs. 1, 1 *a*). The abdominal region is sharply bent upon itself at about its middle; the end of the caudal region and all the fins are wanting. The characters of the skull and dentition are feebly indicated; while the vertebral column and dermal scutes are exhibited in a tolerably satisfactory manner.

The cranium, clearly identical with that of the type specimen, is best shown from above and below in B. M. no. 49793 (Pl. XVI, figs. 2, 2 *a*) and in the Willett Collection no. 115 (fig. 3). The postorbital region occupies about one quarter of its total length, and is as long as broad, with nearly parallel sides, and the occipital border excavated with a sharp re-entering angle. The frontal region between the orbits is exceedingly constricted, while the rostrum is very slender and truncated in front. All the external bones are ornamented with a few delicate longitudinal ridges, occasionally subdivided into tubercles. When the roofing bones are removed, as shown in fig. 2, the well-ossified but small supra-occipital (*socc.*) can be observed beneath, bearing a slight vertical median crest behind; but it was completely covered by the relatively large parietals. These bones (*pa.*) are shown in external impression in fig. 2 *a*, from their inner aspect in fig. 3. They are an unsymmetrical pair of quadrangular plates, meeting throughout their length in a slightly wavy suture, and marked on their outer face by about two longitudinal ridges which extend from border to border, while other short ridges and tubercles are observed behind. The squamosals (*sq.*) are small long and narrow plates at the postero-lateral angles of the skull, scarcely produced further forward than the parietals. The frontals (*fr.*) extend and expand backwards to form at least half of the postorbital region, and these are not a quite symmetrical pair. As shown in fig. 3, their narrow interorbital region rises on each side into a small supraorbital flange. Their anterior ends, as shown in fig. 2, seem to have been a little expanded again on the rostral region. As indicated by the impression, fig. 2 *a*, the outer face of the frontals is ornamented with a few longitudinal ridges, which do not quite reach the hinder margin and are not connected or correlated with the ridges on the parietals. The well-ossified, long and narrow mesethmoid (*eth.*) is very slightly expanded in front, and its anterior extremity is curiously excavated in such a manner as to give it the appearance

of being a tube. This element is also ornamented with a few fine, longitudinal ridges which terminate just behind the anterior expansion.

The orbit is relatively large, its diameter equalling about one quarter of the total length of the skull. No cheek-plates have been observed; but in some specimens a piece of a smooth, convex, bony plate is seen (*e. g.*, fig. 2, *x.*), and this may represent part of an ossified sclerotic.

The mandibular suspensorium is vertical, so that the quadrate articulation is directly beneath the occiput. As shown in fig. 4, the hyomandibular (*hm.*) and the triangular metapterygoid (*mpt.*), also perhaps the quadrate, are very thin plates. The ectopterygoid (fig. 1 *b*, *ect.*) is relatively small, not forming more than a third of the palato-ptyergoid arcade. It is expanded behind into a thin triangular lamina in a vertical plane, while its anterior portion is a comparatively stout bar, tapering to a point in front where it rests in a groove on the upper face of the palatine. Its anterior half alone bears teeth, which are very small, slender-conical, and recurved, arranged in a close series or perhaps clustered. The palatine (figs. 1*a*, 1*b*, 2, 5, *pl.*) is large and stout and always conspicuous in the fossils. It is a lenticular plate of bone, pointed at each end, and its maximum width seems to have been contained about seven times in its total length. It must have been originally disposed in an almost horizontal plane, perhaps a little inclined outwards and downwards. Its upper face is nearly flat and smooth, only impressed at the hinder end with the groove for the ectopterygoid. Its inferior face is completely covered with a dense cluster of teeth, which are partly seen in the broken specimens represented in figs. 5, 6. These teeth are slender, smooth, recurved cones, enamelled only at the tip, and with so large a pulp-cavity that they are readily broken and display their hollowness. When they are removed, their bases of attachment are shown (as in fig. 6) to have been in very shallow sockets. The maxilla is unknown. The premaxilla (figs. 2, 4, *pmx.*) is a long and slender, thin lamina of bone, meeting its fellow of the opposite side in an extended symphysis anterior to the cranial rostrum, and tapering in front to a sharp point. It is smooth, but marked by one or two longitudinal ridges. Its straight oral margin bears a single close and regular series of minute conical teeth. The mandible is also long and slender, and the bluntly-pointed, symphyseal end of the dentary (fig. 4, *d.*) is not so far forwards as the anterior end of the premaxillary rostrum. The upper jaw thus projects beyond the lower jaw. The anterior part of the dentary at least is ornamented with a few longitudinal ridges, and its oral margin bears a series of teeth like those of the premaxilla. Some specimens also suggest that there may have been a cluster of small conical teeth on the inner face of the mandible.

The opercular and branchiostegal apparatus are almost unknown; but one specimen in the Willett Collection (no. 113), from the Upper Chalk of Brighton, seems to show a normal suboperculum, which is quite smooth and more than twice as broad as deep.

At least fifty vertebræ are indicated in the type specimen (figs. 1, 1*a*) and in another coiled-up example from the zone of *Micraster coranguinum* at Charlton, Kent (B. M. no. 41198). Both these, however, are incomplete at the caudal extremity; and a third fossil (B. M. no. 43512), with remains of this extremity, suggests that the total number of vertebræ was about seventy. As shown by many specimens, the centra are delicate, smooth, constricted cylinders, all originally pierced by a thin persistent strand of the notochord. Those of the abdominal region, from 35 to 40 in number, are almost always exposed from above or below, on account of the great development of their transverse processes; while the caudal vertebræ are usually seen in side view. As shown in section in a continuous series in B. M. no. 41198, the twelve foremost vertebral centra are remarkably elongated, the length of each being about three times as great as its maximum diameter. In these the transverse process is a delicate narrow ledge of bone, extending from end to end of the centrum on each side, and widest in its anterior half (as indicated in the type specimen, fig. 1*a*). Some delicate rod-like fragments probably represent ribs. Beyond the twelfth vertebra the remainder of those of the abdominal region are larger and stouter, with the centra only about twice as long as deep. The peculiar transverse processes also increase in stoutness and prominence until, at about the thirty-second vertebra, the length of the laterally directed anterior process equals that of the centrum. Each of these processes is still laminar, but strengthened by being bent upwards on its long axis. Some anterior caudal vertebræ are seen in the type specimen (fig. 1*a*), and still better in a fragment of a larger individual (fig. 7), which has been unsatisfactorily figured by Agassiz (*tom. cit.*, pl. lxvi*a*, fig. 5). In these vertebræ the transverse process has already disappeared or been displaced downwards to form the base of the hæmal arch. The neural arch (*n.*) forms a low straight ridge, extending the whole length of the centrum, and marked with some very fine pittings. The short, slender, backwardly-inclined neural spine is fixed at its hinder end; while a small prominence like a zygapophysis occurs at its anterior end. The hæmal arch (*h.*) is also a low ridge, but it extends only along the anterior two thirds of the centrum, while it is abruptly truncated in front and behind. Its lower margin is somewhat excavated, and its hinder produced angle bears a slender hæmal spine.

The post-temporals (fig. 2*a*, *ptt.*) are a pair of triangular plates, longer than broad, impinging on the supraoccipital. The external-lateral margin of each is slightly thickened and produced at the hinder angle; the upper face of the bone is smooth. The pectoral arch and fins are only known by unsatisfactory fragments. In one specimen in the Willett Collection (no. 113), from the Upper Chalk of Brighton, the pectoral fin is shown to be rather large and inserted close to the ventral border. The anterior pelvic fin-rays are remarkably stout (B. M. no. P. 1905*a*). A fragment of the caudal fin in B. M. no. 43512 shows that it was large and powerful. The other fins are only known by scattered pieces of their rays.

Owing to the nature of the chalky matrix in which the fossils of this species occur, they can only be cleaned and prepared with difficulty, and the dermal armour is nearly always much damaged or destroyed. The characteristic scutes are best displayed in the type specimen (figs. 1, 1*a*, 1*c*); but even in this remarkable fossil their arrangement can only be understood by reference to the well-preserved fishes of allied species from the Cretaceous of Sahel Alma, Mount Lebanon (described in 'Catal. Foss. Fishes B. M.,' pt. iv, 1901, pp. 174—184). The armour clearly begins immediately behind the head and extends along the whole length of the trunk to the base of the caudal fin (B. M. no. 43512). The wide angle between the right and left halves of each dorso-lateral and ventro-lateral scute indicates that the body was rounded, not much laterally compressed. The paired dorso-lateral and ventro-lateral rows are apparently similar and consist of triradiate scutes (fig. 1*c*, *d*., *v*.), which scarcely overlap. Their anteriorly directed arm is longest and acutely pointed. Their backwardly inclined arms diverge at a considerable angle, and the longer of the two is truncated distally to meet its fellow of the opposite side at the middle line of the body, while the shorter arm has a more tapering or rounded end. The outer face of each scute is strengthened by a thickening of the hinder border and by a longitudinal median ridge, which bears a recurved, uncinat spine throughout the posterior abdominal and caudal region: it is also sometimes marked with a few short radiating lines and tubercles. One specimen (fig. 8) shows a gradual enlargement of the three ventro-lateral scutes just in advance of the pelvic fin, and the anterior abdominal scutes seem to be narrower than those further back; but otherwise there is little variation in size in any part of the series. The scutes of the lateral line, as seen on the anterior abdominal region, are narrow and almost heart-shaped, with their two hinder arms diverging at a very acute angle (fig. 1*c*, *l*.); and some of them are clearly tuberculated. It seems likely, however, that towards the middle of the body they become more distinctly tri-radiate, as in *Leptotrachelus triquetus* (see B. M. no. P. 4863); for a detached scute of the lateral line in Dr. G. J. Hinde's Collection, probably referable to *L. elongatus*, has widely divergent posterior arms. This scute (figured in Proc. Geol. Assoc., vol. x, pl. i, fig. 7) bears a prominent recurved spine above the tube for the slime-canal, and its hinder border is faintly and coarsely serrated. On the flanks of the caudal region there are sometimes traces of very thin and smooth lath-shaped plates, which were probably connected with the free arms of the scutes of the dorso-lateral and ventro-lateral series, as in the Lebanon species.

Remarks.—Worm-burrows lined with miscellaneous scales and other fish-remains are not uncommon in the Chalk, and portions of these were erroneously assigned to *L. elongatus* by Agassiz, *loc. cit.*, p. 259, pl. lxvi*a*, figs. 3, 4. They were originally described under the name of *Muraena levesiensis* by Mantell, 'Foss. South Down' (1822), p. 232, pl. xxxiv, fig. 11; pl. xl, fig. 2. Their true nature was first demonstrated by W. Davies, Geol. Mag. [2], vol. vi (1879), p. 145. Similar

fossils are known from the Turonian of Bohemia (*Lepidenteron longissimum*, A. Fritsch, 'Rept. u. Fische böhm. Kreideform.', 1878, p. 19, fig. 45).

Horizons and Localities.—Probably Turonian zones: neighbourhood of Lewes, Sussex; Cuxton, Kent. Zone of *Micraster coranguinum*: Charlton, Bromley, and Dover, Kent. Undetermined Senonian zones: Brighton; Norwich.

Family HALOSAURIDÆ.

A Cretaceous genus, *Echidnocephalus*, from the Senonian of Westphalia, is essentially identical with the existing *Halosaurus* (Text-fig. 17).¹ An allied extinct genus, *Enchelurus*, is also widely distributed in the Chalk.

Genus **ENCHELURUS**, W. von der Marck.

Enchelurus, W. von der Marck, Palæontogr., vol. xi, 1863, p. 58.

Generic Characters.—Vertebrae very short and numerous, marked with delicate longitudinal striæ; neural arches in the abdominal region expanded into narrow laminae. Paired fins small, about equal in size; dorsal fin at least as deep as long, arising opposite to or behind the pelvic fins; anal fin much extended; a separate fringing caudal fin, pointed behind. Scales small, those of the lateral line apparently thickened but not enlarged.

Type Species.—*Enchelurus villosus* (W. von der Marck, *loc. cit.*, p. 58, pl. ix, fig. 5, and A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, 1901, p. 165), from the Senonian of Westphalia.

Remarks.—This genus differs from *Halosaurus* in the separation of the anal from the caudal fin, which surrounds the pointed end of the body. It is best known by a species from the Upper Cretaceous of Sahel Ahna, Mount Lebanon (*Enchelurus syriacus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, 1901, p. 165, pl. xii, figs. 1, 2).

1. **Enchelurus anglicus**, A. S. Woodward. Plate XV, fig. 3; Text-figure 18.

1901. *Enchelurus anglicus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 167, pl. xii, fig. 3.

Type.—Imperfect fish from one of the Cenomanian zones; British Museum.

Specific Characters.—An imperfectly known species probably attaining a length of about 2·5 cm. Operculum as deep as broad, gently rounded and not crimped at the hinder border.

¹A. S. Woodward, "On *Echidnocephalus*, a Halosaurid Fish from the Upper Cretaceous Formation of Westphalia," Proc. Zool. Soc., 1897, pp. 268-271, pl. xviii.

Description of Specimens.—The type specimen in the Enniskillen Collection exhibits the head with the abdominal region as far as the pelvic fins. It has already been described and figured, *loc. cit.*, and is shown in outline in Text-fig. 18. The only other known specimens are fragments of the trunk, one in the British Museum (Pl. XV, fig. 3), the other in the Brighton Museum (Willett Collection no. 105).

The cranium is exposed from above in the type specimen (Text-fig. 18) and shows its characteristic shape. The postorbital region is crushed at the sides, but seems to have been slightly broader than long; while the interorbital and rostral regions are very narrow, with indications of a rather large eye. The external bones are smooth, or marked only by lines of growth. The parietals (*pa.*) are an unsymmetrical pair of irregularly square plates, which clearly meet in the middle line and extend half the length of the postorbital region. They are flanked by the squamosals (*sq.*), which are relatively large and completely cover the otic region.

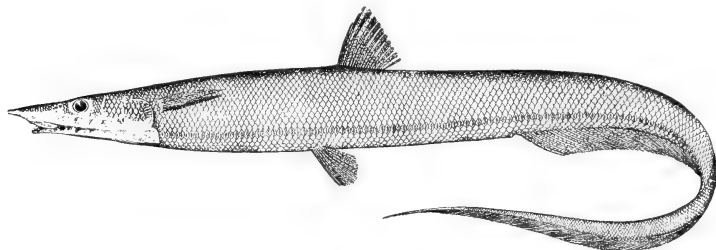


FIG. 17. *Halosaurus oweni*, Johnson; about one-third nat. size.—Existing in moderately deep sea. After Goode and Bean.

The frontals (*fr.*) meet in a wavy suture, and their narrow interorbital portion articulates in front with the equally narrow mesethmoid (*eth.*), which is only slightly expanded at its anterior end. There is an ossified ectethmoid or prefrontal (*prf.*). The quadrate is displaced on the right side of the fossil, and exhibits a small postero-superior cleft, evidently to clasp a symplectic. The entopterygoid (*enpt.*), seen on the left side, is a large laminar bone, slightly more than twice as long as deep. Remains of the premaxillæ, beneath the end of the mesethmoid, indicate that they must have been relatively small, with a delicate rod-like extension behind. They distinctly bear minute teeth. The maxilla (*mx.*), shown on both sides, is relatively very large and closely similar to that of *Halosaurus* in general shape. Its anterior portion is a stout narrow bar extending forwards above the premaxilla, while its larger hinder portion is a considerable laminar expansion, not externally ornamented. Its dentition is uncertain. Stout and blunt, small, conical teeth are seen in the chalk above its anterior end, but these may have been borne by another element. The detached and displaced left

articulo-angular shows that the coronoid region of the mandible rose in a gradual slope from the mandibular articulation. The dentary, of which the upper edge is indicated by *md.* in Text-fig. 18, seems to have been slender. The gape of the mouth must have been small, and the relatively large inferior limb of the preoperculum extends forwards to the articulation of the mandible. The operculum (*op.*) is as deep as broad, rounded behind, and quite smooth on its outer face.

The number of vertebrae is uncertain, but the type specimen shows at least 36 in advance of the pelvic fins. The centra in this specimen are much crushed and imperfect, but they are well seen in Pl. XV, fig. 3. They are all deeper than long, and must have been pierced by a large persistent strand of the

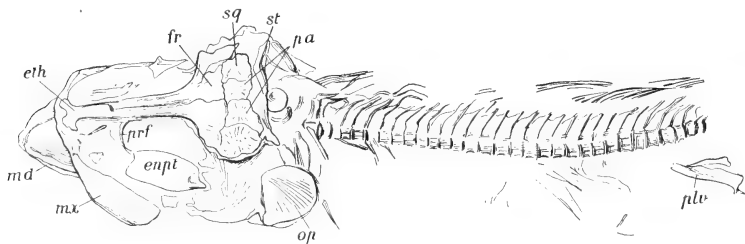


FIG. 18. *Enchelurus anglicus*, A. S. Woodward; outline-sketch of type specimen, nat. size, showing remains of head from above, abdominal region in left side-view.—Probably from a Cenomanian zone; Kent. Enniskillen Collection (B. M. no. P. 4249). *enpt.*, entopterygoid; *eth.*, mesethmoid; *fr.*, frontal; *md.*, mandible; *mx.*, left maxilla; *op.*, left operculum; *pa.*, parietals; *plv.*, pelvic bones; *pnf.*, prefrontal; *sq.*, squamosal; *st.*, supratemporal.

notochord. Their sides are strengthened by several delicate longitudinal ridges. The neural arches in the abdominal region are deep laminar expansions, each bearing a loose, slender spine. Those in the caudal region are less elevated, with a comparatively stout spine firmly fixed to their postero-superior angle. Each haemal arch in the caudal region is fixed to the anterior edge of the centrum.

A pair of narrow plates, which taper to their point of meeting in the middle line, rest on the occipital border of the type specimen and appear to represent supratemporals (Text-fig. 18, *st.*). Only fragments of the pectoral arch are seen. Traces of the pelvic (*plv.*) and dorsal (*do.*) fins are seen respectively in Text-fig. 18, and in Pl. XV, fig. 3. Otherwise the fins are unknown.

Remains of scales in the type specimen prove them to have been rather large, thin, and smooth.

Horizons and Localities.—Zone of *Holaster subglobosus*: Glynde and Amberley, Sussex; probably also Burham, Kent.

Family CTENOTHRISSIDÆ.

A family of Cretaceous fishes closely related to the existing Clupeidæ and remarkable for the forward position of the enlarged pelvic fins, which are inserted just below and behind the pectoral fins. The skull is comparatively primitive in having the parietal bones partly meeting in the median line. The pectoral arch is normal in the overlap of the post-clavicular plate by the clavicle.

Genus **CTENOTHRISSA**, A. S. Woodward.

Ctenothrissa, A. S. Woodward, Ann. Mag. Nat. Hist. [7], vol. iii, 1899, p. 490.

Generic Characters.—Head large; trunk fusiform and laterally compressed,

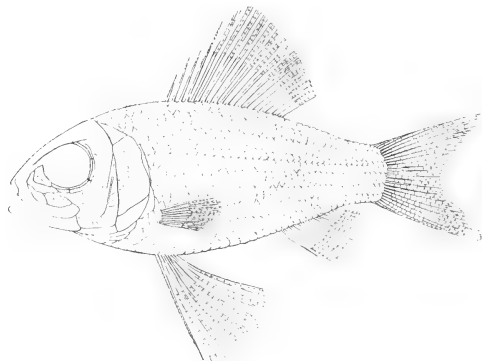


FIG. 19. *Ctenothrissa vexillifer* (Pictet); restoration, about nat. size.—Upper Cretaceous; Hakel, Mt. Lebanon.

with lower face of abdominal region flattened. Maxilla robust and arched, with two supramaxillæ; mandible a little prominent, and gape not extending behind the middle of the large orbit; teeth very small and conical. Vertebrae 30 to 40 in number, half being caudal. Dorsal fin much deepened, occupying about half of the back; anal fin small; caudal fin deeply forked. Scales pectinated, large and regularly arranged, none enlarged or thickened, some extending over the cheek and part of the opercular apparatus; lateral line conspicuous.

Type Species.—*Ctenothrissa vexillifer* (*Beryx vexillifer*, F. J. Pictet, Poiss. Foss. Mt. Liban, 1850, p. 8, pl. i, fig. 1), from the Upper Cretaceous of Hakel, Mount Lebanon (Text-fig. 19).

Remarks.—The species of this genus were originally referred to *Beryx* by Agassiz and Pictet. They are readily distinguished from all Berycoids by the characters of the jaws, vertebral column, and fins.

1. *Ctenothrissa radians* (Agassiz). Plate XVII; Plate XVIII, figs. 1—5; Text-figure 20.

1835-38. *Beryx radians*, L. Agassiz, Poiss. Foss., Feuille, p. 55, and vol. iv, pp. 4, 118, pl. xiv b, fig. 7; pl. xiv c, figs. 7—9.

1888. *Beryx radians*, A. S. Woodward, Proc. Geol. Assoc., vol. x, p. 326, pl. i, fig. 9.

1899. *Ctenothrissa radians*, A. S. Woodward, Ann. Mag. Nat. Hist. [7], vol. iii, p. 491.

1901. *Ctenothrissa radians*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 122, pl. x, figs. 1—4.

Type.—Imperfect fish from one of the Turonian zones; British Museum.

Specific Characters.—A robust species attaining a length of about 25 cm.

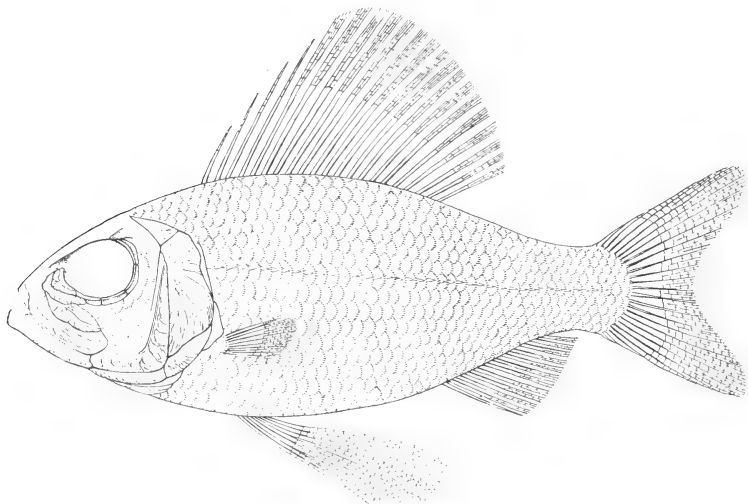


FIG. 20. *Ctenothrissa radians* (Agassiz); restoration, about two-thirds nat. size.—English Chalk.

Length of head with opercular apparatus somewhat less than the maximum depth of the trunk and contained about twice in the length from the pectoral arch to the base of the caudal fin. Head and opercular apparatus with a fine rugose ornament; the supranaxilla remarkably short and deep; operculum about twice as deep as broad, not covered with scales, except perhaps in its antero-superior portion. Vertebrae approximately 40 in number. Pelvic fins with 7 or 8 stout rays, which, when adpressed to the trunk, extend to the anal fin; dorsal fin with 20 to 25 rays, arising just in front of a point opposite the insertion of the pelvic fins; anal fin, with at least 12 rays, arising opposite the hinder end of the dorsal fin. Scales moderately large; lateral line extending along the ninth series above that

which forms the ventral border of the flank; all the scales very finely serrated and deeply pectinated, those of the anterior portion of the fish at least also marked with large flattened tubercles.

Description of Specimens.—The type specimen in the Mantell Collection (no. 4029) exhibits the general form of the fish, with the flattened lower face of its abdominal region. It also displays the characters of the squamation. The fossil, however, is too imperfect to show clearly that it does not belong to the Berycidae, and the foremost ray of the pelvic fin might readily be mistaken for a spine, as it is described by Agassiz. The detached head figured by Agassiz (*tom. cit.*, pl. xiv *b*, fig. 7) evidently shows the toothed Clupeoid maxilla; but this specimen does not appear to have been received by the British Museum with the Mantell Collection, and it has not hitherto been identified.

The cranium is short, deep, and narrow, with a relatively small cerebral region. The plane of its roof slopes straight downwards to the sharply pointed snout; while the basicranial axis is bent upwards at the anterior end of the brain-case (B. M. no. 25936). The greater part of the cranial roof is formed by the frontal bones (Pl. XVII, fig. 2 *a, fr.*), which are somewhat longer than wide. They are widest at the hinder border of the orbit and rapidly taper forwards, where they overlap the very small and narrow mesethmoid (*eth.*). They are bent on each side into a supraorbital flange, which bears a coarsely rugose or tubercular ornamentation; they are also traversed by a pair of large longitudinal slime-canals, which bifurcate in front. The parasphenoid bone is stout, and its hinder part forms the floor of a large basicranial canal, seen especially in B. M. no. P. 5685.

The mandibular suspensorium is inclined forwards, so that the articulation of the mandible is beneath the anterior part of the orbit. The hyomandibular is rather stout, narrow, and deep, with a vertical laminar ridge on its outer face (B. M. no. P. 5418). The quadrate (Pl. XVII, fig. 1, *qu.*) is deeply cleft behind to clasp the symplectic element (B. M. no. 41775). Both the ectopterygoid and entopterygoid are thin, toothless laminae. The premaxilla (Pl. XVII, fig. 2, *pmx.*, and fig. 2 *b*) is relatively small, and cannot have formed more than one quarter of the toothed edge of the upper jaw. Its anterior end rises into a large ascending process, which makes an angle greater than a right-angle with the tooth-bearing portion. Its teeth are very small, blunt cones, arranged in a narrow cluster. The maxilla (Pl. XVII, figs. 1, 2, *mx.*, and fig. 3) is a large stout lamina, shaped like that of *Clupea*. As seen from the inner face (fig. 3), its tooth-bearing portion is nearly four times as long as deep, truncated at the hinder end, and rising into a very slight prominence at the middle of the upper edge. Its gently curved oral border bears a single series of small and nearly uniform, bluntly conical teeth. The anterior part of the bone is a narrow bar, not quite half as long as the tooth-bearing lamina: it gradually rises to the palatine articulation. The exposed part of the outer face of the maxilla is finely ornamented with rugae, which are mainly

longitudinal in direction and most conspicuous near the hinder end and oral border. The bone seems to have been traversed by a slime-canal just below the level of the anterior ascending process; while its upper part is overlapped by two large supramaxillæ. The latter plates (Pl. XVII, figs. 1, 2, *smx.*; Pl. XVIII, fig. 1, *smx.*) are also finely ornamented with vermiculating rugæ. The posterior and larger of these plates (*smx.* 2) is irregularly triangular in shape, with the apex behind, and its antero-superior angle produced forwards into a slender point (Pl. XVII, fig. 1, *smx.* 2; also seen in B. M. no. P. 7652). It is considerably longer than deep, and the most conspicuous feature of its external ornament is a wavy, longitudinal groove extending along its middle. The anterior supramaxilla (*smx.* 1) is rounded behind and tapers in front, where its smoothness seems to indicate overlap by the large foremost plate of the circumorbital ring. It is twice as long as deep, its length equalling that of the posterior supramaxilla. The mandible is remarkably short and deep, the depth in the coronoid region equalling nearly half of its total length. The articulo-angular bone is comparatively small, extending only into the lower half of the coronoid region. It is quite smooth except at the thickened lower edge, which is slightly rugose. The greater part of the dentary bone is exposed in the type specimen figured by Agassiz, and portions of it are also seen in the originals of Pl. XVII, figs. 1, 2 (*d.*); Pl. XVIII, fig. 1 (*d.*). It is truncated at the symphysis and rapidly rises into the great coronoid process. Its outer face is smooth except at the lower border, where it is traversed by a deep longitudinal groove for a slime-canal, and the upper edge of this is sometimes slightly rugose. The teeth indicated by Agassiz can hardly be seen in the type specimen; but such minute conical teeth were clearly present (B. M. no. P. 5418).

In the hyoid arch the epihyal (Pl. XVIII, fig. 2, *eph.*) is slightly longer than deep, while the ceratohyal (fig. 3, *ch.*) is comparatively long and slender, with its upper ends united by a supplementary plate of bone. The urohyal (Pl. XVIII, fig. 4) is a relatively large thin bony lamina, quadrangular in shape and not much longer than deep. As shown by a fragment represented in Pl. XVII, fig. 4, the branchial arches bear a close series of long and slender gill-rakers.

The cheek is covered partly by circumorbital plates, partly by scales. Most of the circumorbital plates (Pl. XVII, fig. 1, *co.*) are small and form a very narrow rim behind and below the orbit; but the foremost element of the series, which may be termed antorbital (*ao.*), is relatively large and expanded. These plates are traversed by a deep groove for the slime-canal, and their prominent orbital rim is ornamented by coarse rugæ or tubercles. The large antorbital, well seen in Pl. XVII, fig. 1 (*ao.*), is deepest at the anterior end, where its depth equals about half its extreme length. Its coarsely rugose, everted orbital rim is especially large, overhanging an extensive hollow for the slime-canal; and below this the flat lamina of the bone is ornamented with fine tubercles and ridges, which are directed chiefly at right angles to the lower edge. The scales behind and below the

circumorbital ring resemble those of the trunk, being deeply overlapping, rugose, and serrated.

The opercular apparatus is narrow and deep, with a finely rugose ornament, and very little of it, if any, can have been covered with scales. The preoperculum (Pl. XVII, figs. 1, 2, *pop.*) is sharply bent at its angle, and the lower limb is about two-thirds as long as the ascending limb. It is much expanded at the angle, and the ascending limb tapers more rapidly than the lower limb. It is traversed by a very deep groove for the slime-canal, and the bone of its lower limb is coarsely crimped as well as rugose. The operculum (Pl. XVII, figs. 1, 2, *op.*) is trapezoidal in shape, narrowest above and widest at the lower end, with a slightly wavy hinder edge. The length of its lower edge equals nearly two-thirds that of its anterior edge. Its ornamental rugæ radiate backwards and downwards from the point of suspension, and are absent on a narrow antero-superior area, which seems to have been covered with scales, though these have not been observed. The suboperculum, well seen in the type specimen and in the original of Pl. XVII, fig. 1 (*sop.*), is triangular in shape, its maximum depth at the front edge equalling half its length. Its antero-superior angle is produced into a short ascending peg. Its external ornament is confined to the anterior half of the bone, but no scales have hitherto been noticed over the hinder smooth area. The interoperculum (Pl. XVII, figs. 1, 2, *iop.*) is relatively large and extended, with its delicate rugose ornament chiefly disposed in lines at right-angles to the lower edge. The number of branchiostegal rays is uncertain, but there cannot have been less than eight, perhaps ten. Those attached to the epiphyal (Pl. XVIII, fig. 2, *br.*) are broad, rapidly tapering, curved laminæ; those fixed to the middle and front half of the ceratohyal (Pl. XVIII, fig. 3, *br.*) are smaller, thinner, and more sharply bent.

The vertebral column is imperfectly known, but the specimen represented in Pl. XVIII, fig. 1, shows that the vertebræ are small and at least 35, perhaps as many as 40 in number. The centra are about as long as deep, and strengthened with fine longitudinal ridges. The ribs are stout and extend almost or quite to the ventral border. The neural and hæmal arches in the caudal region are fused with the anterior part of each centrum.

A single pair of transversely extended supratemporal plates overlaps the occiput. Each of these bones (Pl. XVII, fig. 1, *st.*) is nearly triangular in shape, with the apex directed to meet its fellow of the opposite side in the median line. A transverse slime-canal must have occupied a deep groove in its outer face, which is coarsely rugose and crimped. The post-temporal (Pl. XVII, fig. 1, *ptt.*) is a thin lamina of bone, probably about as deep as broad, having a rounded hinder edge and the posterior half ornamented with delicate, radiating rugæ. The supraclavicle (Pl. XVII, fig. 2, *scl.*) is a narrow lamina, about four times as deep as wide, of nearly uniform width except where it tapers at the lower end to overlap the clavicle. Its outer face is almost smooth. The clavicle (Pl. XVII, fig. 5, *cl.*; Pl. XVIII,

fig. 1, *cl.*), best seen in Brit. Mus. no. P. 5685, is sigmoidally bent and tapers at each end. Its upper half expands behind into a nearly smooth, crescent-shaped plate, which is exposed above the pectoral fin, and clearly overlaps a smooth, post-clavicular plate both in the type specimen and in the original of Pl. XVII, fig. 5 (*pcl.*). The scapula, partly exposed in the latter specimen (*sc.*), is relatively small and pierced by an oval foramen. The coracoid, seen in position (*cor.*), is narrow and deep, produced and tapering below to the clavicular symphysis. The pectoral fin must have been small and delicate, and it is rarely seen. Remains in the original of Pl. XVII, fig. 1 (*pct.*) and in B. M. nos. 49083, P. 5418 *a*, show that it consisted of ten to twelve rays, which are quite feeble compared with those of the other fins. The pelvic bones are so far forwards that they may have been originally in actual contact with the lower end of the clavicles. They are much-expanded laminae (broken in Pl. XVII, fig. 5, *plv.*), but their exact shape has not been clearly observed. The pelvic fins are shown by several specimens to be remarkably large, extending, when adpressed to the trunk, to the origin of the anal fin. Each of them consists of seven or eight very stout rays, all articulated and all, except perhaps the foremost, finely divided in their distal half. In the original of Pl. XVII, fig. 5, the base of the foremost and stoutest ray of the pelvic fin is ornamented with transverse, partly oblique rugae; while its articulated distal portion is represented only by scattered fragments. The median fins are best shown in Pl. XVII, fig. 1, but they are always imperfect in the fossils. The dorsal (*do.*) is remarkably extended and elevated, and is proved to have consisted of at least 20 rays, probably more. Where the distal parts of the rays are preserved, they are clearly articulated and sometimes divided. The length of some of the hinder rays equals about two-thirds the depth of the trunk at their insertion. The anal fin (*a.*) arises nearer to the caudal than to the pelvic fins, and seems to have had its origin opposite the hinder end of the dorsal fin. It comprises about 12 rays, all articulated and most of them finely divided distally. The caudal fin (Pl. XVII, fig. 1, *c.*; Pl. XVIII, fig. 1, *c.*) is stout and clearly forked.

The regular and uniform arrangement of the squamation is well shown in many specimens. The number of scales in each transverse series on the flank of the abdominal region is 18 or 19, the lowermost being bent along its median longitudinal axis to enter both the flank and the flattened ventral face. This narrow face is covered by three longitudinal series of scales in addition to the half-scales of each side. All the scales are deeply overlapping, and their exposed area is usually deeper than broad. When unabraded (Pl. XVIII, figs. 5, 5 *a*) they are externally ornamented with large flattened tubercles, which give the surface a reticulate appearance, especially conspicuous in the abdominal region; and they are always finely pectinated at their rounded hinder border (fig. 5 *a*). When abraded, the very fine concentric lines of growth are seen. The overlapped portion of each scale, displaying only these lines of growth, is truncated at the

front border, where it is deepest. The inner face (Pl. XVII, fig. 6) is smooth, with a slight thickening at the hinder margin, where the fine pectinations of the outer face are just evident. The lateral line traverses the ninth scale of each series above the bent ventral scale. It is marked by a row of short prominent ridges, each widest at the front of the exposed area of the scale on which it rises and tapering to a point behind. The ridges often exhibit irregular longitudinal flutings, as already noticed by Agassiz.

Horizons and Localities.—Zones of *Holaster subglobosus* to *Terebratulina gracilis*: neighbourhood of Lewes, Sussex. Zone of *Holaster subglobosus*: Glynde, Clayton, and Arundel, Sussex; Dorking, Surrey; and Burham, Kent.

2. **Ctenothrissa microcephala** (Agassiz). Plate XVIII, figs. 6—9; Plate XIX, figs. 1, 2.

1835—38. *Beryx microcephalus*, L. Agassiz, Poiss. Foss., Feuill., p. 55, and vol. iv, pp. 4, 119, pl. xiv b, figs. 3—6; pl. xiv c, fig. 10.

1850. *Beryx microcephalus*, F. Dixon, Geol. Sussex, p. 372, pl. xxxiv, fig. 3.

— *Beryx radians*, F. Dixon, *ibid.*, p. 371, pl. xxxvi, fig. 4 (*error*).

1888. *Beryx microcephalus*, A. S. Woodward, Proc. Geol. Assoc., vol. x, p. 327.

899. *Ctenothrissa microcephala*, A. S. Woodward, Ann. Mag. Nat. Hist. [7], vol. iii, p. 491.

1901. *Ctenothrissa microcephala*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 124, pl. x, figs. 5, 6.

Type.—Distorted head and abdominal region from one of the Turonian zones; British Museum.

Specific Characters.—An elongated species, attaining a length of about 15 cm. Length of head with opercular apparatus equal to the maximum depth of the trunk, which is contained about twice in the length from the pectoral arch to the base of the caudal fin. Head as in *C. radians*, but operculum nearly smooth and almost covered with thin scales. Pelvic fins apparently less elongated than in *C. radians*. Scales very large, the lateral line extending along the fourth series above that which forms the ventral border of the flank; serrations comparatively coarse, and no tubercular ornament in front of them.

Description of Specimens.—The type specimen in the Mantell Collection (no. 4034) exhibits only fragmentary remains of the head with part of the characteristic squamation. The lower portion of a head and trunk in the same collection, also figured by Agassiz (*tom. cit.*, pl. xiv c, fig. 10), displays equally characteristic scales, with traces of the pelvic, anal, and caudal fins, and some fragments of the head-bones. The general proportions of the fish, noted in the specific diagnosis, are better shown by the specimens figured by Dixon and those referred to in the British Museum Catalogue.

Some of the principal characters of the species are illustrated in Pls. XVIII, XIX. The head (Pl. XIX, fig. 2) appears to be closely similar to that of *C. radians*, with indications of a well-developed slime-canal system. The jaws are of the same shape, with corresponding supramaxillæ (*smx.* 1, 2); but the teeth of the upper jaw are relatively larger and perhaps blunter than in the species already described. The right premaxilla, with its characteristic dentition, is shown of thrice the natural size in Pl. XIX, fig. 2 *a*. The preoperculum, somewhat abraded and broken in the original of Pl. XIX, fig. 2 (*pop.*), is also nearly similar to that of *C. radians*; but the operculum, of which fragments remain in the originals of Pl. XVIII, fig. 6, Pl. XIX, fig. 2 (*op.*), differs in being for the most part smooth and covered with thin, pectinated scales. The vertebral centra are as small as in *C. radians*, and the ribs (Pl. XIX, fig. 1, *r.*) are clearly stout and long.

The supraclavicle (Pl. XIX, fig. 2, *scl.*) is deep and smooth, while the clavicle, imperfectly exposed in Pl. XIX, fig. 2 (*cl.*), has the usual proportions. The pectoral fin, shown turned downwards and forwards in the same figure (*pct.*) is small and delicate, with about 10 rays. The pelvic fins (Pl. XVIII, figs. 6, 7, *plv.*; Pl. XIX, fig. 1, *plv.*) arise immediately behind the pectorals on the inferior flattened face of the body. When seen from below (Pl. XVIII, fig. 7), their bases are observed to be separated by a large, median, ovoid scale. Each consists of about 9 rays, which are shown to be very stout when the fin is spread (Pl. XIX, fig. 1, *plv.*). The rays are divided and articulated distally, where they are thus usually imperfect in the fossils; but the original of Pl. XIX, fig. 1, seems to show that they were not so excessively elongated as in *C. radians*, the fin, when adpressed to the trunk, not reaching the anal fin. The depth and extent of the dorsal fin (Pl. XVIII, fig. 6, *do.*; Pl. XIX, fig. 1, *do.*) are not quite clear; but it arises opposite a point just behind the insertion of the pelvic fins, and it must have occupied nearly, if not quite, half the length of the back. Its rays are very stout, articulated and divided distally. The anal fin (Pl. XVIII, fig. 6, *a*; Pl. XIX, fig. 1, *a*) consists of equally stout rays, which are also much elongated and divided and articulated distally. This fin seems to have been deeper than long, with about 10 rays, which would nearly reach the base of the caudal fin if they were adpressed to the trunk. The long base of the foremost anal fin-rays bears a fine rugose ornament. The caudal fin (Pl. XVIII, fig. 6, *c.*) is deeply forked, and its rays are closely articulated and divided beyond a very short base.

The scales are so large that there are only nine in each transverse series on the flank, the lowermost being bent in the usual manner to enter both the flank and the flattened ventral face. This narrow face (Pl. XVIII, fig. 7) is completely covered by the half-scales of each side with only one median longitudinal row of the ordinary scales. The principal flank-scales (Pl. XVIII, fig. 9) are nearly twice as deep as broad, and their exposed area is more than twice as deep as broad. Their hinder border is coarsely and strongly pectinated, but the rest of their outer

face is smooth or only marked by the very delicate concentric lines of growth. Their covered area exhibits feeble traces of a few grooves radiating backwards from the middle of the scale (Pl. XVIII, fig. 8). The lateral line traverses the fourth scale of each series above the bent ventral scale. It is strongly marked, as in *C. radians*, but its short ridges are nearly always quite smooth.

Horizons and Localities.—Zones of *Holaster subglobosus* to *Terebratulina gracilis*: neighbourhood of Lewes, Sussex. Zone of *Holaster subglobosus*: Glynde, Clayton, and Arundel, Sussex; Reigate, Surrey; Halling and Burham, Kent.

Genus **AULOLEPIS**, Agassiz.

Aulolepis, L. Agassiz, Poiss. Foss., vol. v, pt. ii, 1844, p. 109.

Generic Characters.—Head large; trunk fusiform and laterally compressed, with lower face of abdominal region flattened. Maxilla robust and arched, with two supramaxillæ; mandible a little prominent, and gape extending to the back of the large orbit; teeth very small and conical. Anal fin small; caudal fin deeply forked. Scales smooth and not pectinated, large and regularly arranged, none enlarged or thickened; lateral line conspicuous.

Type Species.—*Aulolepis typus*, from the English Chalk.

Remarks.—This genus is still known only by the type species. It differs essentially from *Otenothrissa* in the non-pectination of the scales. The number of the vertebræ is uncertain; and the dorsal fin is known merely by unsatisfactory fragments.

1. *Aulolepis typus*, Agassiz. Plate XIX, figs. 3, 4.

1837-44. *Aulolepis typus*, L. Agassiz, Poiss. Foss., vol. v, pt. i, p. 14; pt. ii, p. 109, pl. lx a, figs. 5-8

1888. *Aulolepis typus*, A. S. Woodward, Proc. Geol. Assoc., vol. x, p. 324.

1895. *Aulolepis typus*, A. S. Woodward, Proc. Zool. Soc., 1894, p. 660 (in part), pl. xliii, figs. 4, 6 (non figs. 2, 3, 5).

1900. *Aulolepis typus*, A. S. Woodward, Ann. Mag. Nat. Hist. [7], vol. v, p. 324, pl. ix, fig. 2.

1901. *Aulolepis typus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 127.

Type.—Imperfect fish from one of the Turonian zones; British Museum.

Specific Characters.—The type species, attaining a length of about 20 cm. Length of head with opercular apparatus somewhat exceeding half that of the trunk from the pectoral arch to the base of the caudal fin. Anal fin nearer to the caudal than to the pelvic pair. Lateral line extending along the fifth or sixth

series above that which forms the ventral border of the flank, its ridges quite smooth.

Description of Specimens.—The type specimen in the Mantell Collection (no. 4033) is very imperfect, and not accurately represented in the figure published by Agassiz. It shows only fragments of the head, and lacks the dorsal part of the trunk. The right pelvic fin is mistaken for the pectoral by Agassiz; and hypothetical indications of the supposed pelvic and anal fins are added to the original drawing just mentioned. The mandibular ramus is wrongly restored, and imaginary teeth are represented; while the caudal vertebral centra are considerably too long in the drawing. The enlarged figures of the scales are more nearly accurate.

The best known example of the species (Pl. XIX, fig. 3) is in the Woodwardian Museum, Cambridge, but this specimen resembles the type in lacking the dorsal region of the trunk. Other specimens in the British Museum are more imperfect, but reveal some of the principal characters of the fish. The head seems to be about half as long as the trunk, which is moderately elongated with a rather deep caudal pedicle.

The cranium as seen from above (fig. 3*a*) is triangular in shape, and its greatest width at the occiput equals about two-thirds of its length. The supra-occipital bone (*socc.*) is relatively small, with a median vertical crest on its hinder face. Its upper portion enters the cranial roof, but does not completely separate the parietals (*pa.*), which are much extended antero-posteriorly and meet in the middle line for more than half of their length. The squamosal-pterotic region (*sq.*) also seems to be relatively large, but sinks into a fossa which would be originally occupied by a forward extension of the lateral muscles of the trunk. The frontals (*fr.*) are very large, widest between the eyes, where they expand into a supraorbital flange on either side. They taper rapidly forwards, where the small mesethmoid (*eth.*) projects beneath them. None of these bones are ornamented.

The mandibular suspensorium is only slightly inclined forwards, so that the articulation of the mandible is beneath the hinder border of the orbit. The hyomandibular is narrow and deep. The ectopterygoid (seen in B. M. no. 47932) is a long, narrow lamina of bone, its posterior end bending downwards along the anterior border of the quadrate. The premaxilla is relatively small, occupying the anterior quarter of the toothed edge of the upper jaw, tapering to a point behind, turned up into a short ascending process in front. The maxilla (fig. 3, *mx.*) is arched and shaped like that of *Clupea*. Its exposed face is smooth, and its upper border is overlapped by two large supramaxillæ (fig. 3, *smx. 1, 2*), which are also nearly smooth. Both the premaxilla and maxilla bear clustered minute conical teeth. The mandible is shaped as in *Olenothrissa*, with a comparatively long and deep coronoid region, a short tooth-bearing margin, and truncated symphysis; in fact, quite unlike the hypothetical sketch published by Agassiz. The mandibular

teeth (seen in B. M. no. 47932) resemble those of the upper jaw. The antorbital plate of the circumorbital ring, imperfect in the original of fig. 3 (*ao.*), is smooth, but marked by downwardly radiating branches from the slime-canal which traverses it. Smooth cycloidal scales extend over the postero-inferior part of the cheek.

The opercular apparatus is unornamented, and the operculum (*op.*) is clearly covered with scales. The narrow preoperculum (*pop.*) is sharply bent at the angle, and the lower limb is about two-thirds as long as the ascending limb. The bone is expanded at the angle, where a few radiating ridges mark diverging branches of the slime-canal.

Vertebrae are seen in the caudal part of the type specimen, while scattered remains of them occur in the original of fig. 3 and in other fossils. They are rather small and cannot have been less than 35 in total number. The centra are strengthened with delicate longitudinal ridges. The hæmal spines at the base of the caudal fin are stout and expanded, but do not appear to have been fused into a hypural plate.

The clavicular arch (seen in B. M. no. 49883) is shaped as in *Ctenothrissa radians* (p. 81), but the post-temporal is unornamented. The smooth post-clavicle is clearly overlapped by the clavicle (B. M. no. 49883). The scapula (shown in Proc. Zool. Soc., 1894, pl. xliii, fig. 6) is broader than deep and pierced by an oval foramen. The small and delicate pectoral fin (fig. 3, *pet.*) seems to have comprised about twelve rays. Each pelvic fin consists of nine comparatively stout rays, of which only the bases are usually preserved (fig. 3, *plv.*). The anal fin is fragmentary in the original of fig. 3 (*a.*); but more satisfactory remains in B. M. no. 47932 show that it was quite small and short-based, its elevation probably not exceeding half the depth of the trunk at its insertion. It arises somewhat nearer to the caudal fin than to the pelvic pair. The dorsal and caudal fins are only known by a few fragments of rays.

The scales are so large that there would probably be only about ten in each transverse series on the flank, though the number is uncertain. They are all rather thick, and quite smooth or only marked by the fine concentric lines of growth. The ordinary scales (fig. 3*b*) have a rounded or almost bent hinder margin, their exposed area being nearly rhombic in shape and somewhat deeper than broad. Those of the lateral line (fig. 4), which seem to form the fifth or sixth longitudinal row from the ventral border, are truncated behind, and marked by the prominent, smooth ridge of the slime-canal, which is always widest in front and pointed behind. The ridge of the lateral line is conspicuous along the whole length of the fish from the post-temporal plate to the base of the caudal fin. When seen from inside, the scales exhibit the peculiar thickening of the hinder margin already noted in *Ctenothrissa radians* (p. 83).

Horizons and Localities.—Turonian zones: neighbourhood of Lewes. Zone of *Holaster subglobosus*: Burham, Kent; Dorking, Surrey.

Family CLUPEIDÆ.

The only genus of herrings hitherto recognised in the English Chalk belongs to the more primitive section of the family, in which the abdominal border is rounded and covered merely with the ordinary scales.

Genus **SYLLÆMUS**, Cope.

Syllæmus, E. D. Cope, Vert. Cret. Form. West (Rep. U.S. Geol. Surv. Territ., vol. ii, 1875), p. 180.

Leptichthys, A. Stewart, Amer. Geol., vol. xxiv, 1899, p. 78.

Generic Characters.—Trunk subcylindrical, not much laterally compressed; head and opercular region compressed to a sharp edge below. Snout acutely pointed, but not produced; cranial roof slightly arched from side to side, with a shallow rhombic median depression in the frontal region; orbit very large, and sclerotic capsule ossified; cleft of mouth extending beneath the anterior half of the orbit; maxilla very stout, with a single close series of minute conical teeth; one slender supramaxilla; mandible short and deep, with a similar regular series of slightly larger teeth. Preoperculum forming a great triangular expansion, and suboperculum relatively deep. Pectoral fins inserted slightly above the ventral border; pelvic fins very remote; dorsal fin imperfectly known, moderately extended, with some of the anterior rays not articulated, but having their right and left halves not fused together; anal fin apparently absent; caudal fin deeply forked, with slender lobes. Scales large, very deeply overlapping, smooth, and not serrated or crenulated on the posterior margin. Lateral line conspicuous, a simple tube piercing all the scales it traverses, arising low down on the flank not far above the pectoral fin.

Type Species.—*Syllæmus latifrons* (E. D. Cope, *op. cit.*, 1875, p. 181), from the Upper Cretaceous of Pike's Peak, Colorado, U.S.A.

Remarks.—This genus has hitherto been placed in the Percesoces by Cope and the present writer; but the careful preparation of one specimen in the British Museum has now demonstrated that a preopercoid arch is present in its pectoral girdle, while there can be no longer any doubt that its so-called premaxilla is really a maxilla. The osteology of the fish, as now understood, seems to necessitate its reference to the Clupeidæ, in which family one species has already been placed by Alban Stewart.¹

¹ *Leptichthys agilis*, A. Stewart, Univ. Geol. Surv. Kansas, vol. vi, 1901, p. 372, pl. lxxii, fig. 1.

The only known English species of *Syllæmus* was originally referred by Dixon to the genus *Calamopleurus*, which was founded by Agassiz on fragments of an entirely different fish from the Upper Cretaceous of Brazil.¹

1. *Syllæmus anglicus* (Dixon). Plate XX; Plate XXI, figs. 1, 2.

1850. *Calamopleurus anglicus*, F. Dixon, Geol. Sussex, p. 375, pl. xxxii, figs. 11, 12.

1888. *Calamopleurus anglicus*, A. S. Woodward, Proc. Geol. Assoc., vol. x, p. 324.

1901. *Syllæmus anglicus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 351.

Type.—Head and abdominal region, probably from zone of *Holaster planus*; British Museum.

Specific Characters.—A large and robust species attaining a length of about 45 cm. Length of head with opercular apparatus scarcely exceeding the maximum depth of the trunk and contained slightly more than four times in the total length to the base of the caudal fin. A narrow border of very fine granulations immediately above the teeth on the outer face of the maxilla; anterior margin of preoperculum much thickened, especially at the angle, from which numerous undulations, almost ridges, radiate; operculum smooth. Pectoral fins long and narrow, with about 14 rays; pelvic fins with 8 rays, the foremost stoutest, arising much nearer to the caudal than to the pectoral fins; dorsal fin arising at a distance from the occiput equal to the total length of the skull. About 8 or 10 transverse series of scales in advance of the dorsal fin, each with approximately 12 scales on either side; the scales when abraded exhibiting traces of very fine parallel or slightly radiating lines directed antero-posteriorly in the exposed area.

Description of Specimens.—The type specimen in the Egerton Collection exhibits the imperfectly preserved head and abdominal region, and is shown of the natural size from the left lateral aspect in Pl. XX, fig. 1. It displays the long, pointed form of the head, the proportions of the jaws, the upper teeth, the rounded shape of the trunk, the characters of the scales, and the position of the pectoral, pelvic, and dorsal fins. The complete length of the fish, with its forked caudal fin, is indicated only by two known specimens, one from an undetermined zone at Shalford, near Guildford (Pl. XX, fig. 2), the other from a Turonian zone near Duntun Green, Kent (W. J. Lewis Abbott Collection). These three specimens together exhibit the form and proportions of the species noted in the diagnosis.

The head is laterally compressed and deeper than broad, with a rather acute but not produced rostrum. The cranium is well ossified, and its flattened roof

¹ *Calamopleurus cylindricus*, L. Agassiz, Edinb. New Phil. Journ., vol. xxx, 1841, p. 84; A. S. Woodward, Catal. Foss. Fishes B. M., pt. iii, 1895, p. 489.

slopes gradually downwards from the straight occipital border to the rostrum. All the exposed bones are smooth. The basicranial axis is clearly straight (Pl. XXI, fig. 1, *pas.*). The occipital and otic regions have not been well observed; but the supraoccipital, bearing a slight crest, rises into the hinder overlapped margin of the cranial roof, and thus probably separates the parietals as in the existing Clupeidæ. The parietals and squamosals, or perhaps pterotics, enter into the hinder portion of the exposed cranial roof; but this is formed chiefly by the large frontal bones (*fr.*), which are widest behind and gradually taper forwards, without any expansion in the prefrontal (ectethmoid) region. The frontals unite with the parietals and squamosals in a very wavy suture, and are marked with a considerable number of small pittings connected with the sensory canal-system. They also exhibit a sharply-marked rhomboidal depression in the middle between the hinder part of the orbits. The small mesethmoid is truncated in front. The eye is large, and the sclerotic is distinctly ossified (Pl. XX, fig. 1, *scl.*). There are also delicate, smooth circumorbital plates, apparently forming a complete cover for the cheek (B. M. no. P. 9053, from Gault).

The mandibular suspensorium is inclined so far forwards that the small, fan-shaped quadrate (Pl. XXI, fig. 1, *qu.*) is situated immediately below the orbit. The entopterygoid (*enpt.*) has also been observed as a delicate, ovoid lamina of bone; but nothing more is known of this arcade. The premaxilla is unknown, but must have been very small. The maxilla is especially stout and forms most of the upper border of the mouth. It is imperfect anteriorly in the type specimen figured (Pl. XX, fig. 1, *mx.*), but is better shown in another imperfect head in the British Museum (no. 47302). It is slightly curved upwards in front and is rather deep throughout its length, except quite at the posterior end where it tapers. Its oral border, as seen in the type specimen, bears a single, uniform, close series of minute, blunt teeth; and immediately above this border the outer face of the bone is finely granulated or rugose. The comparatively delicate single supramaxilla is only represented by a fragment in the type specimen (Pl. XX, fig. 1, *smx.*); but its complete form is indicated by B. M. no. 47302, which shows that it is a narrow lenticular plate extending about two-thirds of the length of the maxilla. The mandible is rather short, tapering at either end, and deepest at the posterior limit of the gape of the mouth. The dentary (Pl. XX, fig. 1, *d.*) bears teeth similar to those of the maxilla, but somewhat larger and apparently more sharply pointed, as shown especially well by a Gault fossil in the British Museum (no. 36170). Its lower margin is continued backwards as a long process beneath the large articulo-angular bone (*ag.*).

The opercular bones are thin and quite smooth. The exact proportions of the operculum and suboperculum are uncertain, but a line crossing this region in the type specimen (Pl. XX, fig. 1, *op.*, *sop.*) seems to denote the suture between them, and, if so, the suboperculum must have been comparatively deep. Part of this

plate suggesting the same shape is also seen in a specimen from Burham in the Egerton Collection (B. M. no. P. 1853). The preoperculum (Pl. XXI, fig. 1, *pop.*) is relatively enormous, triangular in shape and sharply bent at the angle, with the lower limb slightly larger than its ascending limb. Its concave anterior border is thickened, and the hinder expansion is marked by rounded radiating folds or ridges. The number of the branchiostegal rays is uncertain; but remains in a specimen from Cuxton (B. M. no. P. 9698) seem to show at least 10 of these rays, all very delicate, supported by the ceratohyal. The elongated and laterally compressed ceratohyal, with its upper ends connected by a narrow bar of bone, is seen in impression in the type specimen (Pl. XX, fig. 1, *ch.*).

The vertebræ have only been satisfactorily observed in the caudal region (Pl. XX, fig. 2), where each centrum is about as long as deep, much constricted, and strengthened by a single sharp longitudinal ridge on the middle of either side. Similar centra are feebly indicated in the abdominal region of B. M. no. P. 6532. If they are as uniform in size throughout the trunk as in modern Clupeidæ, the vertebræ must have been over 40 in total number. The neural and hæmal arches in the hinder half of the tail are much thickened and overlap each other, to strengthen the pedicle for wielding the powerful, forked caudal fin.

In the pectoral girdle, the clavicle is only slightly expanded in the plane of the flank above the origin of the pectoral fin; and its inwardly directed lamina forms an acute angle with this expansion, being inclined backwards to meet a well-developed precoracoid arch (Pl. XXI, fig. 2 *a*, *pc.*). Above the pectoral fin there is a long and narrow postclavicular plate (Pl. XXI, fig. 2, *pcl.*), which clearly overlaps the clavicle, as usual in the Clupeidæ. Its outer face is marked by numerous minute pittings. The pectoral fin itself (Pl. XX, figs. 1, 2, *pct.*; Pl. XXI, fig. 2, *pct.*) is placed low down on each flank, and seems to have been received in a shallow hollow when adpressed to the trunk. It must have been long and narrow in shape, comprising not more than 14 rays. The pelvic fins (*plv.*) are extraordinarily remote, arising far behind a point opposite the origin of the dorsal. Indeed, if their paired nature were not distinctly shown by B. M. no. P. 6532, one of them displayed singly might readily be mistaken for an anal fin. Five rays of one of these fins, perhaps a little displaced backwards, are shown in Pl. XX, fig. 2, *plv.*, and the foremost is longest and stoutest; but more rays, probably eight in each fin, are indicated in the other specimen just mentioned. The anterior part of the dorsal fin is best seen in the original of Pl. XX, fig. 2 (*do.*), and in B. M. no. P. 9698, where it consists of closely arranged, broad rays, of which some at least are not articulated. The foremost of these rays is much the shortest, terminating in a slender point; the second is longer but similar; the third seems to have been the longest, though it is not completely preserved. The hinder part of the dorsal fin is only known by scattered fragments. There is no trace of an anal fin. The caudal fin (Pl. XX, fig. 2, *c.*) is deeply forked, with slender lobes. Two or three

gradually lengthening slender rays appear outside the basal half of its longest ray above and below; while this and the other outermost rays, not far from their base, exhibit numerous closely arranged, oblique articulations, each in the form of a finely jagged line (Pl. XX, fig. 2 *a*).

The scales are large, very deeply overlapping, smooth, and not serrated or crenulated on the posterior margin. When the outermost layer is partly destroyed, they exhibit a few very fine, parallel or slightly radiating lines directed antero-posteriorly in the exposed area. It is impossible to count them accurately, but as suggested by the type specimen there seem to have been 12 scales in a transverse series on the flank of the abdominal region, and there are 8 or 10 of these series in front of the dorsal fin. One scale, of ordinary shape, behind the upper end of the pectoral arch (Pl. XX, fig. 2, *x.*), is strongly marked with radiating furrows, which were evidently in connection with a sensory canal. The lateral line (Pl. XX, fig. 1, *ll.*) is prominent as a simple tube piercing all the scales it traverses. It begins in front low down on the flank, not far above the pectoral fin, and rises slightly as it is traced backwards to the middle of the fish.

Horizons and Localities.—Turonian zones: neighbourhood of Burham, Cuxton, and Dunton Green, Kent. Zone of *Holaster subglobosus*: Burham and Dover, Kent; Glynde, Sussex. Undetermined zones: Guildford and Shalford, Surrey.

Family CHIROCENTRIDÆ.

The sole surviving member of this family, *Chirocentrus dorab* (Text-fig. 21) of the Indian Ocean, is interesting as having the intestine short, with a rudiment of the spiral valve, which is so characteristic of the ganoid fishes. The Cretaceous

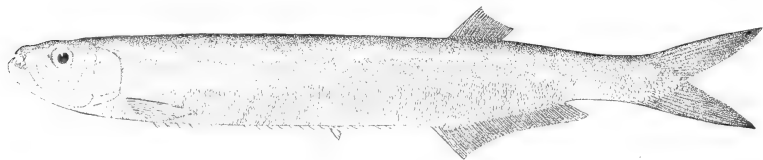


FIG. 21.—*Chirocentrus dorab*, Forsk.; about one seventh nat. size.—Existing in the Indian Ocean, Chinese, and Japanese Seas.

genera here referred to the Chirocentridæ exhibit a skeleton essentially identical with that of *Chirocentrus*, differing only from the latter by the implantation of the teeth in deep sockets, and by two features on the side of the skull. *Ichthyodectes* and *Portheus* at least lack the small vacuities in the base of the outer side of the

parietal-epiotic crest, which are filled with adipose tissue¹ in *Chirocentrus* (Text-fig. 22A, B, v.); while they exhibit a large and deep fossa in the middle of the side of the otic region—a feature characteristic of Elopine and Clupeoid fishes but not of *Chirocentrus*.

Genus **ICHTHYODECTES**, Cope.

Ichthyodectes, E. D. Cope, Proc. Amer. Phil. Soc., vol. xi, 1871, p. 536.

Generic Characters.—Teeth hollow, in deep sockets, not compressed to a sharp edge; those of the maxilla, as also those of the dentary, almost uniform in size, and those of the premaxilla not much enlarged. Successional teeth formed directly beneath the functional teeth, and no foramina on the inner face of the jaw below the alveolar border. No presymphysial bone. Trunk and fins apparently as in *Chirocentrus*.

Type Species.—*Ichthyodectes etenodon* (Cope, Proc. Amer. Phil. Soc., vol. xi, 1871, p. 536, and Vert. Cret. Form. West, 1875, p. 207, pl. xlv, figs. 1—4), from the Upper Cretaceous (Niobrara Group) of Kansas, U.S.A.

Remarks.—All the known remains of this genus, especially those from the English Chalk, are fragmentary; but specimens from Kansas, and a fish apparently of the same genus from Mount Lebanon, display the principal characters of the trunk and fins, which agree closely with the corresponding parts of *Chirocentrus*. Various isolated pieces of cranium, vertebral column, fins, and scales, may thus be generically determined without much hesitation; and a few typical fragments, which correspond in size with one or other of the first two English species recorded below, seem to be worthy of special description. These are treated here because they have not yet been found in definite association with the jaws, by means of which alone the species of *Ichthyodectes* are diagnosed.

Cranium.—The occipital portion of a skull represented in Pl. XIX, figs. 5, 5a, and another incomplete cranium in the British Museum (no. 49810) are essentially identical with the same parts of skulls already described from the Kansas Chalk.² The cranium is shown to have been somewhat deeper than broad, with very prominent supraoccipital and epiotic crests. It has indeed the conformation of the cranium of *Chirocentrus*, as indicated in the accompanying Text-figs. 22A—D. The large supraoccipital (*socc.*) is a saddle-shaped bone, overlapped by the frontals anteriorly, and rising behind, where it is extended between the muscles in a

¹ According to a communication made to the author by Dr. W. G. Ridewood.

² See especially O. P. Hay, "On certain Genera and Species of North American Cretaceous Actinopteros Fishes," Bull. Amer. Mus. Nat. Hist., vol. xix, 1903, p. 57, fig. 42. Also A. Stewart, "Teleosts of the Upper Cretaceous," Univ. Geol. Surv. Kansas, vol. vi, 1901, p. 297, pl. xlix.

sloping upper part of the otic region. The postfrontal or sphenotic ossification (*ptf.*) is rather large, and is exposed in the somewhat hollowed anterior part of this region. When the otic bones are viewed from the side beneath the overhanging pterotic (as in Pl. XIX, fig. 5 *a*), they are observed to be excavated in the middle by a large and deep fossa (*fo.*). A moderately large opisthotic (*opo.*) occurs above the basioccipital (*bocc.*), and its anterior edge is suturally united with the pro-otic (*pro.*). This element is very large and pierced by the usual foramen for the exit of the fifth nerve. The pterotic, sphenotic, and pro-otic enter the hyomandibular facette (*hm.*). The parasphenoid (Text-fig. 22 *b*, *pas.*) forms the floor of a very large basicranial canal and extends upwards on either side in a short and broad process, which adjoins the front part of the pterotic. The basicranial axis formed by the parasphenoid is only slightly arched, without any sharp bend at the anterior termination of the otic region. The prefrontal or ectethmoid (*prf.*) is remarkably massive for articulation with the thickened palatine, which supports the maxilla.

Among minor characters shown in Text-figs. 22 *A—D*, it may be noted that the skull of *Ichthyodectes* differs from that of *Chirocentrus* in the relatively greater extent of its epiotic element, the larger size of its hinder supraoccipital crest, and the very slight elevation of its pterotic crest (*u*).

Vertebræ.—None but small fragments of vertebral column have hitherto been found in the English Chalk. All the centra, except a few at the two extremities of the column, are pitted on each side by two deep, longitudinally-extended excavations (Pl. XXI, fig. 3); while they also receive the bases of the neural and hæmal arches in pits. Some of the terminal caudal vertebræ have already been figured by Agassiz¹ and Dixon² under the name of *Tetrapterus minor*, on the erroneous assumption that they belong to the fish whose rostrum is now known as *Protosphyræna minor*. A more satisfactory specimen of five vertebræ in natural sequence is shown in Pl. XXI, fig. 4. The centra (*c.*) of these terminal caudals are closely pressed together, with rugose sides which exhibit only a small remnant of a pit. As seen in end-view in the specimen figured by Agassiz, they are pierced by a small foramen for the passage of a persistent remnant of the notochord. The procumbent neural arches (*n.*) are relatively small and not much expanded at the base. The hæmal arches (*h.*), mistaken by Agassiz for neurals, are remarkably stout and large, with a basal expansion which firmly clasps but is not fused with the centrum. The hæmal canal is diminutive and (as shown by Dixon's figure) the arch encircling it is much wider than long. The sides of each hæmal spine are flattened and marked with some faint oblique ridges. The hæmal spines posterior to those here described are small triangular expansions.

Scales.—The scales proved by the Kansas fossils to belong to *Ichthyodectes* and

¹ L. Agassiz, Poiss. Foss., vol. v, 1837, pl. lx *a*, figs. 11—13.

² F. Dixon, Geol. Sussex, 1850, pl. xxxi, fig. 16.

allied genera were named *Cladocyclus* by Agassiz, who referred all the English specimens to one species, *Cladocyclus lewesiensis* (Poiss. Foss., vol. v, pt. i, 1837-44, pp. 8, 103, pl. xxv a, figs. 5, 6). Two typical examples are shown in Pl. XXI, figs. 5, 6. They must have been relatively large, and most of them are ovoid with the longer axis vertical. Their exposed portion (*e.*) is a comparatively small sector covered with small pits, each surrounded by a raised border. The hinder edge of the scale is not crimped or serrated. The overlapped portion is marked by the fine concentric lines of growth and by a few conspicuous radiating grooves, which are often interrupted.

1. *Ichthyodectes minor* (Egerton). Plate XIX, fig. 6 (?); Text-figure 23.

1850. *Hypsodon minor*, P. M. G. Egerton, in F. Dixon. Geol. Sussex, p. xiv, pl. xxxii,* fig. 9.

1877. *Ichthyodectes minor*, E. T. Newton, Quart. Journ. Geol. Soc., vol. xxxiii, p. 520, pl. xxii, fig. 14.

1901. *Ichthyodectes minor*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. iv, p. 102.

Type.—Imperfect mandible, probably from one of the Turonian zones; British Museum.

Specific Characters.—A species of moderate size, with mandible about 14 cm. in length. Oral border of dentary bone nearly straight, with a slight convexity

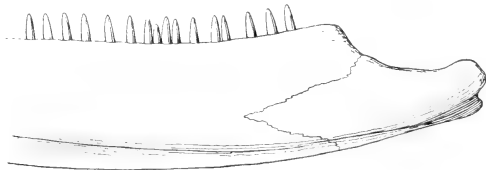


FIG. 23.—*Ichthyodectes minor* (Egerton); outline of left mandibular ramus, outer aspect, two thirds nat. size, restored from the two mandibular rami of the type specimen.—Chalk; Sussex.

towards its anterior end; the outer face of the bone not sharply bulging outwards in a longitudinal ridge; its depth at the symphysis about equal to one-quarter the total length of the mandibular ramus; teeth rather large and stout, upright and straight, not curved at their apex; total number of tooth-sockets in dentary about 30.

Description of Specimens.—The type specimen in the Dixon Collection exhibits the greater part of both mandibular rami, the one figured in Dixon's work, the other by E. T. Newton (*loc. cit.*). It forms the basis of the above diagnosis and

PLATE XIV.

FIG.	PAGE.
1. <i>Enchodus lewesiensis</i> (Mantell); distorted head and abdominal region, left lateral aspect, and (1a) imperfect skull, upper aspect.—Probably a Senonian zone; Brighton. Willett Collection no. 65, Brighton Museum. <i>ag.</i> , articulo-angular; <i>ao.</i> , antorbital, displaced downwards over upper jaw; <i>br.</i> , branchiostegal ray; <i>c.</i> , first caudal vertebra; <i>co.</i> , a posterior circumorbital plate; <i>d.</i> , dentary; <i>enpt.</i> , entopterygoid; <i>fr.</i> , frontal; <i>mpt.</i> , metapterygoid; <i>mx.</i> , maxilla; <i>op.</i> , operculum; <i>pop.</i> , preoperculum; <i>ptt.</i> , post-temporal; <i>socc.</i> , supraoccipital; <i>sop.</i> , suboperculum, displaced and partly covered; <i>x.</i> , supposed thickened neural spine.	58.
2. Ditto; fragmentary jaws, left side, outer aspect.—Upper Chalk; probably Sussex. Beckles Collection (B. M. no. P. 6459). <i>ecpt.</i> , ectopterygoid; <i>pl.</i> , palatine; other letters as in fig. 1.	58.
3. Ditto; part of right palato-ptyergoid arcade, inner aspect, showing two foremost teeth (<i>a.</i> , <i>b.</i>) on ectopterygoid (<i>ecpt.</i>), with a fragment of the overlapping palatine (<i>pl.</i>).—Probably a Turonian zone; near Lewes. Mantell Collection (B. M. no. 4157).	59.
4. Ditto; imperfect right palatine, outer aspect.—Chalk; probably Sussex. Beckles Collection (B. M. no. P. 6459 a).	60.
5. Ditto; part of left palatine, inner aspect.—Chalk; Kent. Harford Collection (B. M. no. P. 5661).	60.
6. Ditto; outline of transverse section of palatine tooth, the gently curved outer face directed to the right and downwards, the bulging inner face to the left and upwards.—Probably a Turonian zone; near Lewes. Mantell Collection (B. M. no. 4184).	60.
7. Ditto; imperfect right dentary, outer aspect, showing three downward processes at the symphysis, and the large anterior tooth with its successor (<i>x.</i>).—Chalk; probably Sussex. Beckles Collection (B. M. no. P. 6458).	60.
8. Ditto; right opercular apparatus of small individual, outer aspect, showing nearly complete shape of suboperculum (<i>sop.</i>) displaced over operculum (<i>op.</i>), with the well-preserved lower expansion of the preoperculum (<i>pop.</i>).—Zone of <i>Micraster coranguinum</i> ; Bromley, Kent. Dixon Collection (B. M. no. 25880).	61.
9. <i>Enchodus pulchellus</i> , A. S. Woodward; head with opercular apparatus, the type specimen, left lateral aspect.—Probably a Cenomanian zone; Kent. Egerton Collection (B. M. no. P. 1703). <i>hm.</i> , hyomandibular; <i>pas.</i> , parasphenoid; <i>pmx.</i> , premaxilla; other letters as in figs. 1, 2.	62.
10. Ditto; right side of small head, etc., inner aspect.—Zone of <i>Holaster subglobosus</i> ; Betchworth, Surrey. Collection of Mr. W. P. D. Stebbing, F.G.S. <i>pct.</i> , part of pectoral fin; <i>s.</i> , dermal scute of lateral line; other letters as above.	63.
11. Ditto (?); large left palatine bone, lacking end of tooth and postero-superior expansion, outer and (11 a) inner aspects.—Zone of <i>Holaster subglobosus</i> ; Burham, Kent. B. M. no. 47926.	63.

All the figures of the natural size.

PLATE XV.

- | FIG. | | PAGE. |
|------|--|-------|
| 1. | <i>Dercetis latiscutatus</i> , sp. nov.; remains of middle portion of trunk, the type specimen, left lateral and partly superior aspect, with one of the dorso-lateral scutes enlarged twice (1 <i>a</i>).—Probably zone of <i>Terebratulina gracilis</i> ; Glynde, Sussex. Willett Collection no. 117, Brighton Museum. <i>d.</i> , <i>d'</i> ., dorso-lateral scutes; <i>f.</i> , rays of dorsal fin; <i>l.</i> , scutes of lateral line; <i>v.</i> , ventro-lateral scutes. | 65. |
| 2. | <i>Dercetis maximus</i> , sp. nov.; remains of head and anterior abdominal region, left lateral aspect, with detached vertebræ (2 <i>a</i>), scutes (2 <i>b</i>), and a fragment of the middle of the same fish (2 <i>c</i>), the type specimen.—Zone of <i>Micraster coranguinum</i> ; Grays, Essex. B. M. nos. 31075–82. <i>cl.</i> , clavicle; <i>d.</i> , dentary in fig. 2, dorso-lateral scutes (inner aspect) in fig. 2 <i>b</i> ; <i>fr.</i> , supraorbital part of frontal (inner aspect); <i>l.</i> , scutes of lateral line (inner aspect); <i>mpt.</i> , metapterygoid; <i>pas.</i> , parasphenoid; <i>plr.</i> , pelvic fin-support; <i>qu.</i> , quadrate; <i>v.</i> , ventro-lateral scutes (inner aspect); <i>vb.</i> , vertebræ showing neural arches. | 66. |
| 3. | <i>Enchelurus anglicus</i> , A. S. Woodward; scattered remains of vertebral column and dorsal fin (<i>do.</i>).—Zone of <i>Holaster subglobosus</i> ; Glynde, Sussex. Capron Collection (B. M. no. 49812). | 76. |

All the figures, except 1 *a*, of the natural size.

2a.



2b.



2c.



3.



1, 2. *Dercetis*. 3. *Encheturus*.

PLATE XVI.

FIG.

PAGE.

1. *Leptotrachelus elongatus* (Agassiz); imperfect distorted fish without fins, the type specimen, and its counterpart (1 *a*), with part of the palatopterygoid arcade enlarged one and a half times (1 *b*), and four scutes enlarged four times (1 *c*).—Probably from a Turonian zone; near Lewes. Mantell Collection (B. M. nos. 4132–33). *dl.*, two dorso-lateral scutes in side-view, showing uncinat spine, four times nat. size; *ecpt.*, ectopterygoid; *l.*, anterior scute of lateral line, inner aspect, four times nat. size; *pl.*, palatine, incomplete in front; *v.*, ventro-lateral scute, inner aspect, four times nat. size. 70.
2. Ditto; head exposed from above, with its counterpart (2 *a*), one and a half times nat. size.—Probably from a Turonian zone; Lewes. Capron Collection (B. M. no. 49793). *eth.*, mesethmoid; *fr.*, frontal; *pa.*, parietal; *pl.*, palatine; *pmx.*, premaxilla; *ptt.*, post-temporal; *s.*, dermal scutes; *socc.*, supraoccipital; *sq.*, squamosal; *x.*, probably a sclerotic ossification. 70.
3. Ditto; inner view of hinder half of cranial roof, one and a half times nat. size.—Probably from a Turonian zone; Malling, Sussex. Willett Collection no. 115, Brighton Museum. Letters as in fig. 2. 70.
4. Ditto; head, superior and left lateral aspects.—Zone of *Micraster coranguinum*; Bromley, Kent. B. M. no. 43574. *dl.*, dentary; *eth.*, mesethmoid; *hm.*, hyomandibular; *mpt.*, metapterygoid; *orb.*, orbit; *pmx.*, premaxilla. 71.
5. Ditto; imperfect rostral part of cranium and palatines, upper aspect.—English Chalk. Wetherell Collection (B. M. no. 43098). Letters as in fig. 2. 71.
6. Ditto; fragment of palatine, oral aspect showing bases of attachment for teeth, one and a half times nat. size.—Chalk; Sussex. Dixon Collection (B. M. no. 25803). 71.
7. Ditto; caudal vertebrae, right lateral aspect.—Probably from a Turonian zone; near Lewes. Mantell Collection (B. M. no. 4134). *h.*, haemal arch; *n.*, neural arch. 72.
8. Ditto; three ventro-lateral scutes immediately behind pelvic fin, inner aspect, from same specimen as fig. 2. 73.

Figures of natural size, except when otherwise stated.

1.



1a.

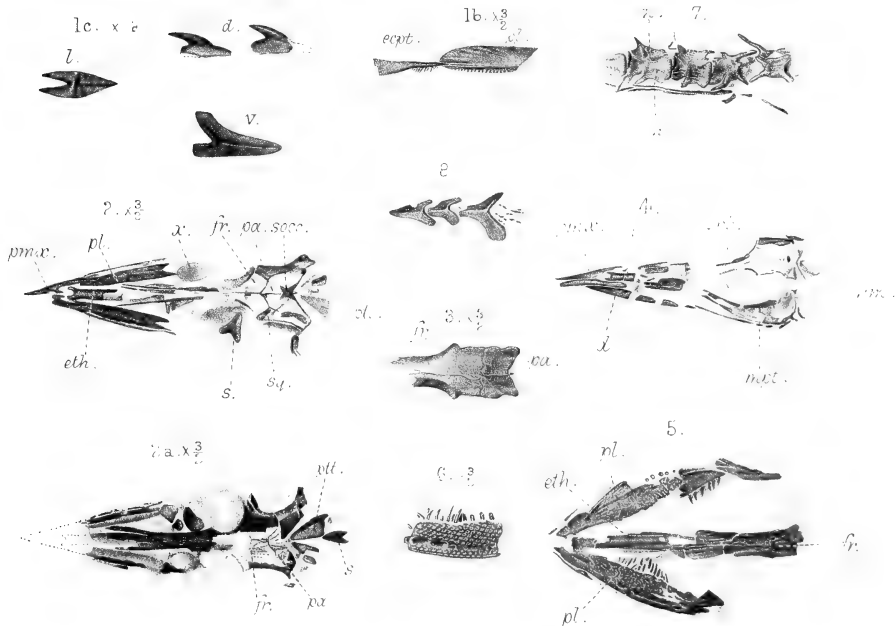
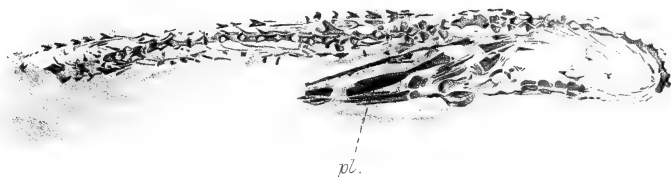


PLATE XVII.

- | FIG. | PAGE. |
|---|-------|
| 1. <i>Otenothrissa radians</i> (Agassiz); right lateral aspect of fish, with jaws displaced forwards.—Zone of <i>Holaster subglobosus</i> ; Glynde, Sussex. Willett Collection no. 38, Brighton Museum. <i>a.</i> , anal fin; <i>ao.</i> , antorbital; <i>c.</i> , caudal fin; <i>co.</i> , circumorbitals; <i>d.</i> , dentary; <i>do.</i> , dorsal fin; <i>iop.</i> , interoperculum; <i>mx.</i> , maxilla; <i>op.</i> , operculum; <i>pct.</i> , pectoral fin; <i>plv.</i> , pelvic fin; <i>pop.</i> , preoperculum; <i>ptt.</i> , post-temporal; <i>qu.</i> , quadrate; <i>smx.</i> 2., posterior supramaxilla; <i>sop.</i> , suboperculum; <i>st.</i> , supratemporal. | 79. |
| 2. Ditto; head with opercular apparatus, right lateral and superior (2 <i>a</i>) aspects, with right premaxilla (2 <i>b</i>) enlarged three times.—Probably from a Turonian zone; Kent. Harford Collection (B. M. no. P. 5699). <i>eth.</i> , mesethmoid; <i>fr.</i> , frontal; <i>pmx.</i> , premaxilla; <i>scl.</i> , supraclavicle; <i>smx.</i> 1, 2., anterior and posterior supramaxilla; other letters as in fig. 1. | 79. |
| 3. Ditto; right maxilla, inner aspect.—Probably from zone of <i>Holaster subglobosus</i> ; Burham, Kent. Mrs. Smith's Collection (B. M. no. 49052). | 79. |
| 4. Ditto; portion of branchial arch with gill-rakers.—Probably from a Turonian zone; Cuxton, Kent. Harford Collection (B. M. no. P. 5685). | 80. |
| 5. Ditto; portion of pectoral and pelvic arches, right lateral aspect. Zone of <i>Holaster subglobosus</i> ; Kent. B. M. no. P. 4843. <i>cl.</i> , clavicle; <i>cor.</i> , coracoid; <i>pcl.</i> , postclavicle overlapped by clavicle; <i>plv.</i> , remains of pelvic fin-support and fin; <i>sc.</i> , scapula. | 82. |
| 6. Ditto; scale of flank, inner aspect, twice nat. size, from same specimen as fig. 5. | 83. |

All the figures, except 2*b* and 6, of the natural size.



PLATE XVIII.

FIG.	PAGE.
1. <i>Ctenothrissa radians</i> (Agassiz); imperfect fish deepened by distortion, exhibiting the vertebral column.—English Chalk. B. M. no. P. 390. <i>c.</i> , caudal fin; <i>cl.</i> , clavicle; <i>dl.</i> , dentary; <i>do.</i> , remains of dorsal fin; <i>mx.</i> , maxilla; <i>sax.</i> 1, 2., anterior and posterior supramaxilla.	81.
2. Ditto; portion of hyoid arch, right lateral aspect.—Probably from a Turonian zone; Sussex. Dixon Collection (B. M. no. 25936). <i>br.</i> , upper branchiostegal rays; <i>ch.</i> , ceratohyal (only hinder end correct shape); <i>eph.</i> , epihyal.	80.
3. Ditto; ceratohyal (<i>ch.</i>) with branchiostegal rays (<i>br.</i>).—Zone of <i>Holaster subglobosus</i> ; Clayton Tunnel, Sussex. Bright Collection (B. M. no. 44836 a).	80.
4. Ditto; urohyal, left lateral aspect.—Zone of <i>Holaster subglobosus</i> ; Burham, Kent. B. M. no. 47911.	80.
5. Ditto; one of the foremost flank-scales and some further back (5 a), twice nat. size.—Probably from a Turonian zone; near Lewes. Mantell Collection (type specimen, B. M. no. 4029).	82.
6. <i>Ctenothrissa microcephala</i> (Agassiz); left lateral aspect of fish, with distorted head and only bases of fins. English Chalk. B. M. no. P. 392. <i>a.</i> , anal fin; <i>c.</i> , caudal fin; <i>do.</i> , dorsal fin; <i>op.</i> , operculum; <i>plv.</i> , pelvic fins.	84.
7. Ditto; ventral aspect of fish, showing pelvic fins (<i>plv.</i>).—Zone of <i>Holaster subglobosus</i> ; Burham. Toulmin Smith Collection (B. M. no. 41689).	84.
8. Ditto; flank-scale, twice nat. size.—Zone of <i>Holaster subglobosus</i> ; Reigate, Surrey. Capron Collection (B. M. no. 49881).	85.
9. Ditto; flank-scales, three times nat. size.—Probably from a Turonian zone; Sussex. Dixon Collection (B. M. no. 25887).	84.

All the figures, except 5, 5 a, 8, 9, of the natural size.

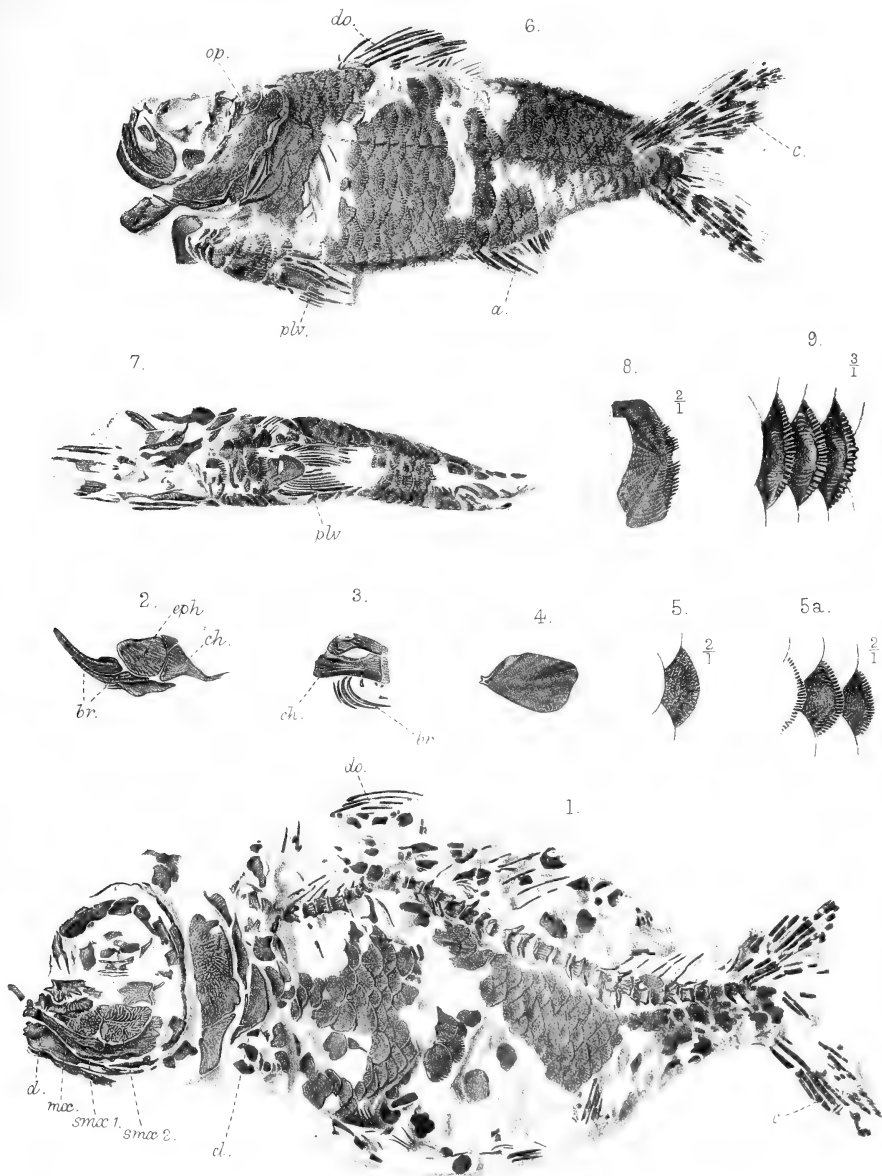


PLATE XIX.

FIG.

PAGE.

1. *Ctenothrissa microcephala* (Agassiz); trunk with remains of fins, left lateral aspect.—Zone of *Holaster subglobosus*; Halling, Kent. B. M. no. P. 9656. *a.*, anal fin; *c.*, caudal fin; *do.*, dorsal fin; *plv.*, pelvic fin; *r.*, rib. 84.

2. Ditto; head, etc., right lateral aspect, with right premaxilla (2 *a*), outer aspect, enlarged three times.—Zone of *Holaster subglobosus*; Arundel, Sussex. Capron Collection (B. M. no. 49884). *cl.*, clavicle; *d.*, dentary; *iop.*, interoperculum; *mx.*, maxilla; *op.*, operculum; *pct.*, pectoral fin; *pmx.*, premaxilla; *pop.*, preoperculum; *ptt.*, post-temporal; *scl.*, supraclavicle; *smx.* 1, 2., anterior and posterior supramaxilla. 84.

3. *Aulolepis typus*, Agassiz; left lateral aspect of fish, incomplete dorsally, with cranial roof (3 *a*), and some scales (3 *b*) three times nat. size.—From a Turonian zone; Southeram, Lewes. Forbes Young Collection (Woodwardian Museum, Cambridge). *a.*, anal fin; *ao.*, antorbital; *c.*, caudal fin; *cl.*, clavicle; *d.*, dentary; *eth.*, mesethmoid; *fr.*, frontal; *mx.*, maxilla; *op.*, operculum; *pa.*, parietal; *pct.*, pectoral fin; *plv.*, pelvic fin; *pop.*, preoperculum; *smx.* 1, 2., anterior and posterior supramaxilla; *socc.*, supraoccipital; *sq.*, squamosal or pterotic or both. 86.

4. Ditto; four scales of lateral line, three times nat. size.—Zone of *Holaster subglobosus*; Dorking, Surrey. B. M. no. 36097. 87.

5. *Ichthyodectes* sp.; hinder portion of cranium, left lateral aspect and also (5 *a*) left infero-lateral aspect.—Zone of *Holaster subglobosus*; Blue Bell Hill, Burham, Kent. S. J. Hawkins Collection (B. M. no. P. 9046). *bocc.*, basioccipital; *epo.*, epiotic; *fo.*, fossa in side of otic region; *fr.*, frontal; *hm.*, hyomandibular facette; *opo.*, opisthotic; *pa.*, parietal; *pro.*, pro-otic; *ptf.*, postfrontal (sphenotic); *pto.*, pterotic; *socc.*, supraoccipital. 93.

6. *Ichthyodectes minor* (Egerton); premaxilla, outer aspect, with two lateral teeth imperfect.—Chalk; Kent. Mrs. Smith's Collection (B. M. no. 49086). 96.

All the figures, except 2 *a*, 3 *b*, 4, of the natural size.

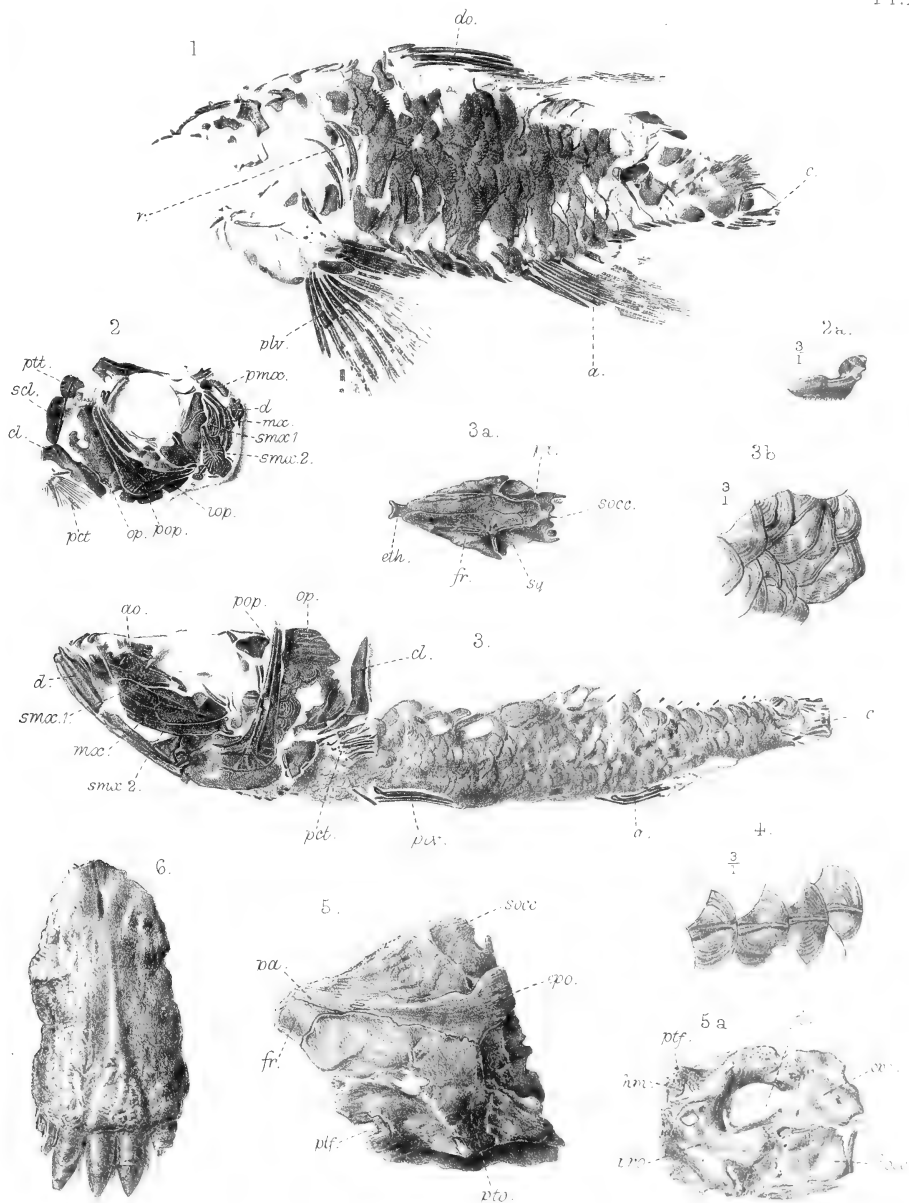


PLATE XX.

FIG.

PAGE.

1. *Syllæmus anglicus* (Dixon); head and abdominal region, the type specimen, left lateral aspect, nat. size.—Probably from zone of *Holaster planus*; Burham, Kent. Egerton Collection (B. M. no. P. 611). *ag.*, articulo-angular; *ch.*, impression of ceratohyal; *d.*, dentary; *do.*, dorsal fin; *ll.*, lateral line; *mx.*, incomplete maxilla; *op.*, operculum; *pct.*, pectoral fin; *plv.*, pelvic fin; *pop.*, preoperculum; *scl.*, ossified sclerotic; *smx.*, portion of supramaxilla; *sop.*, suboperculum. 89.
2. Ditto; imperfect fish, right lateral aspect, three-quarters nat. size.—Chalk; Shalford, near Guildford. Capron Collection (B. M. no. 49737). *c.*, caudal fin; *cl.*, clavicle; *orb.*, orbit; *s.*, scale with radiating marks of slime-canal; other letters as in fig. 1.
2*a.* Portion of two caudal fin-rays, nat. size, to show articulations. 89.

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MONOGRAPH OF THE CRETACEOUS LAMELLIBRANCHIA OF ENGLAND.

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A MONOGRAPH
OF THE
CRETACEOUS LAMELLIBRANCHIA
OF
ENGLAND.

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CONTENTS.

	PAGE
Introduction	vii
Bibliography	xi
Description of species	1
Nuculana	1
Nucula	12
Anomia	27
Arca	32
Barbatia	35
Grammatodon	44
Trigonoarca	47
Cucullæa	49
Isoarca	65
Pectunculus	66
Limopsis	71
Trigonia	73
Mytilus	91
Modiola	92
Crenella	104
Lithodomus	105
Septifer	106
Dreissensia	110
Myoconcha	114
Spondylus	116
Plicatula	134
Pecten (Syneyclonema)	145
„ (Camptonectes)	152
„ (Chlamys)	163
„ (Æquipten)	186
„ (Neithea)	197
Velopecten	218
Himites	220
Additions and corrections	224
Index	227

INTRODUCTION.

DETAILED accounts of three families only of English Cretaceous Lamellibranchs have hitherto been given, namely, the Trigoniidæ by Lycett, and the Nuculidæ and Nuculanidæ by Gardner. Numerous species, however, belonging to various families, were described and figured by J. and J. de C. Sowerby in the 'Mineral Conchology,' and a few also by Parkinson in his 'Organic Remains of a Former World.' A number of works, dealing primarily with the stratigraphy of the Cretaceous beds, also contain descriptions and illustrations of Cretaceous Lamellibranchs from certain districts or from special horizons. One of the earliest of these is 'The Fossils of the South Downs; or, Illustrations of the Geology of Sussex,' by Gideon Mantell (1822), in which a number of Lamellibranchs from the Gault and Chalk of the south-east of England are described and figured; but unfortunately the figures are not very satisfactory, and in many cases the type-specimens are now missing; nevertheless, with the aid of other examples collected from the same localities, it is usually possible to discover the characters of Mantell's species.

Another early work dealing with a special district is the 'Illustrations of the Geology of Yorkshire,' by John Phillips (1829), in which a few Lamellibranchs from the Speeton Clay are figured and others recorded. In 'An Outline of the Geology of Norfolk,' by S. Woodward (1833), the more important species from the Norwich Chalk are illustrated, but descriptions are not given.

In Fitton's great memoir (1836) on 'The Strata between the Chalk and the Oxford Oolite in the south-east of England,' many species of Lamellibranchs, chiefly from Blackdown, are excellently figured and briefly described by J. de C. Sowerby; and most of the type-specimens are now preserved in the Bristol Museum. An account of the more important Lamellibranchs from the Lower Greensand of the Isle of Wight and of the Weald is given by Edward Forbes (1845) in a paper entitled 'Catalogue of Lower Greensand Fossils in the Museum of the Geological Society,' Part I. Most of the specimens therein described may still be seen in the Society's Museum.

Dealing with almost the same area as Mantell's work is the later publication of

F. Dixon on 'The Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex' (1850 or 1852). This contains excellent figures of some Chalk Lamellibranchs by J. de C. Sowerby, but the descriptions of the species are very brief, or in some cases even omitted; moreover, the type-specimens appear to have been lost, and in many instances their original locality is not stated.

The latest work on the Lower Cretaceous Lamellibranchs of England is that by W. Keeping on 'The Fossils and Palæontological Affinities of the Neocomian Deposits of Upware and Brickhill' (1883). Most of the original specimens described in that memoir are preserved in the Cambridge Museum.

A few papers have been published from time to time on the Lamellibranchs of special horizons, such as those of the Cambridge Greensand by Seeley (1861) and by Jukes-Browne (1875, 1877); those of the Faringdon Greensand by Sharpe (1853); those of the Chalk of Cambridge by Etheridge (1881); and those of the Chalk Rock by myself (1897). Various papers dealing with Cretaceous stratigraphy give brief notes on some of the species of Lamellibranchs.

The distribution of the Cretaceous Lamellibranchs of England is indicated in many books and papers on stratigraphical and local geology. The more important of those dealing with the Lower Cretaceous deposits are :—(i) on the Isle of Wight by Fitton (1847), and by Bristow, Reid, and Strahan (1889); (ii) on the Weald by Topley (1875); (iii) on Faringdon by Phillips (1871); (iv) on Lincolnshire by Keeping (1882) and others; (v) on Speeton by Lamplugh (1889, 1896).

The distribution of Lamellibranchs in the Gault is given in great detail by Price (1879); in the Upper Greensand of Blackdown and Haldon by Downes (1882), in that of Warminster by Jukes-Browne (1896), and in the Upper Greensand and Chloritic Marl of Maiden Bradley by Jukes-Browne and Scanes (1901). Amongst the more important works dealing with the zonal distribution in the Chalk are those by Barrois (1876), Meÿer (1874), Jukes-Browne and Hill (1886-96), Griffith (1891), and Rowe (1900, 1901, 1903).

The distribution of Cretaceous Lamellibranchs in different districts is also indicated in numerous memoirs issued by the Geological Survey other than those above referred to; and revised lists showing the general distribution of the species in the Upper Cretaceous rocks are given in the memoir on 'The Cretaceous Rocks of Britain,' by Jukes-Browne, vol. i, 1900, pp. 453-487, and vol. iii (in the press).

The following monograph deals with the Lamellibranchs of all the Cretaceous deposits of England, with the exception of the Wealden formation, which, it is thought, will be more satisfactorily studied in connection with Mollusca of the Purbeck Beds. The species found in the lowest part of the Speeton Series in Lincolnshire and Yorkshire are, as a matter of convenience, included in this work, although they may possibly prove to be of Upper Jurassic age. The families are here considered generally in the order given in Pelseneer's classification.

Some of the disadvantages of taking such a great range of formations are obvious. For example, it is almost impossible to collect personally from such an extensive series of beds, or to become sufficiently familiar with their stratigraphical details and foreign equivalents. The first of these objections is to a large extent removed by the magnificent collections which have been made by many enthusiastic and careful workers in the Cretaceous rocks. Some of these collections are still in private hands; many are now preserved in private museums; but all have been placed freely at my disposal.

Although works dealing with the fossils of limited horizons are often of great service to stratigraphical geologists and collectors, yet, from a palæontological standpoint, such works are apt to be somewhat unsatisfactory, since, owing to the want of sufficient material for comparison from other horizons, the importance of slight differences is liable to be overrated, and a proper idea of the variability of the species can scarcely be obtained. Further, some of the differences between forms from different beds and successive horizons are found to be due merely to dissimilar preservation, or are connected, just as is the case at the present day, with the varying conditions under which the forms lived. Moreover, the knowledge of a genus obtained from the study of a number of species from various horizons is obviously much more thorough than when only a few forms from one horizon are being considered.

From a biological standpoint the most satisfactory method would be to study a small group, such as a genus or family, and trace it through all formations from its earliest appearance to the present day or to the period of its extinction; and further, not to limit oneself, as is usually done, to a single country, but to study the representatives found in all parts of the world. The difficulties of obtaining specimens and of undertaking such extensive travel as that method of work would involve are very great; but quite as great, in the case of Lamellibranchs, is the difficulty of becoming familiar with the enormous literature which exists on this group of molluscs from every geological system. Consequently this method can scarcely be attempted until monographs on the Lamellibranchs found in all the geological systems of most countries have appeared. Moreover, such monographs are urgently needed in stratigraphical investigations. So that, great as is the labour involved in the preparation of a monograph on the Lamellibranchs of any geological system, it can scarcely be regarded as more than a necessary preliminary to the work which will be carried out in the future on many interesting problems in phylogeny and stratigraphy.

Amongst the collections which have been studied in the course of this work are those in the British Museum, the Museum of Practical Geology, and the Geological Society of London; the Museums of Bath, Bristol, Brighton, Cambridge, Exeter, Norwich, and York. In all cases help has been freely given by those

officially connected with the institutions named, and in this respect I desire to express my sincere thanks to Mr. H. A. Allen, Mr. H. Bolton, Mr. W. Rupert Jones, Mr. F. Leney, Mr. E. T. Newton, Mr. R. B. Newton, Mr. H. M. Platnauer, Mr. F. R. Rowley, and Dr. A. Smith Woodward. I am also greatly indebted to several geologists for the loan of specimens from their collections, especially to Dr. H. P. Blackmore, Mr. R. M. Brydone, Mr. G. E. Dibley, Mr. R. Fortin, Mr. C. Griffith, Mr. A. de Grossouvre, Professor E. Holzapfel, Mr. A. J. Jukes-Browne, Mr. G. W. Lamplugh, Mr. J. P. J. Ravn, Mr. C. Reid, Dr. A. W. Rowe, Mr. J. Scanes, Mr. J. W. Stather, Mr. J. F. Walker, and Dr. A. Wollemaun. I must likewise thank Mr. Jukes-Browne and Dr. F. L. Kitchin for their kindness in reading the proofs and for other valuable assistance, whilst in bibliographical difficulties I owe much to the ever-ready help and unrivalled knowledge of Mr. C. Davies Sherborn.

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¹ The date on the title-page is 1850. Morris gives the date of publication as 1852, and Mr. Sherborn believes that the work was not issued before that year.

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THE
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A MONOGRAPH
OF THE
CRETACEOUS LAMELLIBRANCHIA
OF
ENGLAND.

BY
HENRY WOODS, M.A.,
UNIVERSITY LECTURER IN PALEOZOOLOGY, CAMBRIDGE.

PART V.
PECTINIDÆ (*continued*). INTRODUCTION, BIBLIOGRAPHY,
INDEX, AND TITLE-PAGE TO VOL. I.

PAGES 197—232, i—xlili; PLATES XXXIX—XLII.

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Holzapfel, Vogel, and Hennig as another species; it appears to differ in having scaly ribs, a larger anterior ear, and a larger apical angle. Goldfuss' *pulchellus* was thought by d'Orbigny to differ from Nilsson's species, and was named *subpulchellus* in the "Prodrome." *P. miscellus*, Goldfuss,¹ appears to be very near to *P. pulchellus*, and was regarded by d'Orbigny as identical with it. *P. subaratus*, Nilsson,² although similar in form, is easily distinguished by its more numerous ribs, etc.

Type.—Nilsson's specimens came from Köpinge, etc.

Distribution.—Chalk of Trimmingham.

Sub-genus.—NEITHEA, Drouet, 1824.

(*Mém. Soc. Linn. de Paris*, vol. iii, p. 186.)

PECTEN (NEITHEA) ATAVUS, Römer, 1839. Plate XXXIX, figs. 1—5.

1839. PECTEN ATAVUS, *F. A. Römer*. Die Verstein. nord-deutsch. Oolithen-geb. Ein Nachtrag, p. 29, pl. xviii, fig. 21.
1841. — — — Die Verstein. d. nord-deutsch. Kreidegeb., p. 54.
1847. JANIRA ATAVA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 627, pl. ccccxlii, figs. 1—3, 5.
- — NECOMIENSIS, *d'Orbigny*. Ibid., p. 629, pl. ccccxlii, figs. 4, 6—9.
1850. — ATAVA, *d'Orbigny*. Prodr. de Pal., vol. ii, p. 83.
- NECOMIENSIS, *d'Orbigny*. Ibid., p. 83.
1854. PECTEN ATAVUS, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 175 (*partim*).
1855. JANIRA ATAVA, *G. Cotteau*. Moll. Foss. de l'Yonne, p. 117.
- — NECOMIENSIS, *Cotteau*. Ibid., p. 117.
1859. — ATAVA, *J. Vilanova y Piera*. Mem. geogn.-agric. de Castellon, pl. iii, fig. 21.
1861. — — *P. de Loriol*. Anim. Invert. Foss. Mt. Salève, p. 105, pl. xiv, fig. 1.
- NECOMIENSIS, *de Loriol*. Ibid., p. 104, pl. xiv, figs. 2, 3.
1868. ATAVA, *de Loriol*. Valangien d'Arzier (Matér. Pal. Suisse, ser. 4), p. 48.
1870. — *E. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 237, pl. clxxx.
- NECOMIENSIS, *Pictet and Campiche*. Ibid., pp. 240, 251.
- (NEITHEA) ORNITHOPUS, *W. Kepping*. Foss., etc., Neoc. Upware and Brickhill, p. 107, pl. iv, fig. 5.

¹ 'Petrif. Germ.', vol. ii (1833), p. 51, pl. xci, fig. 8.

² 'Petrif. Suecana' (1827), p. 21, pl. ix, fig. 11; Hennig, 'Revision Lamell. i Nilsson's Petrif. Suecana' (1897), p. 46, pl. iii, figs. 14, 16, 17.

Affinities.—Whilst recognising the close resemblance which exists between *P. atavus* and *P. neocomiensis*, Pictet and Campiche thought that the latter could be distinguished from the former by the absence of ribs in the interspaces. Wollemaun, however, by means of a much larger series of specimens, has shown (1896) that the differences which were supposed to separate the two forms are not constant.

The form described by de Loriol¹ as *Janira Matheroniiana* is very similar to *P. atavus*, and may prove to be identical with it.

Janira valangiensis, Pictet and Campiche,² differs from *Pecten atavus* chiefly in the convexity of the left valve.

Remarks.—The English examples of this species are of rather small size, the average height being about 26 mm.; none of them reaches the size of the large forms figured by d'Orbigny and by Pictet and Campiche. Many of our examples are more or less inequilateral, but even in the large specimens from Ste. Croix this character is sometimes noticeable. The anterior ear is also distinctly larger than the posterior in most specimens.

The large example from Upware, figured as *P. (N.) atava* by W. Keeping, is considerably worn, and the ribs in the interspaces are stronger than usual; consequently I am unable to regard it as belonging to *P. atavus*. It is probably only a worn specimen of *P. (N.) quinquecostatus*.

On account of their inequilateral character the specimens from Upware were regarded by W. Keeping as belonging to a distinct species, which he named *P. ornithopus*; but this form also occurs in Brunswick, and Wollemaun has shown that it cannot be separated from *P. atavus*.

Types.—Römer's types came from the Hils-conglomerate of Schandelah and Schöppenstedt. Römer's figure is not quite satisfactory, but any doubt which may formerly have existed as to the nature of his species has been removed by Wollemaun, who has obtained other specimens from the same locality. D'Orbigny's specimens of *P. neocomiensis* came from the Hauterivian near Neuchâtel, etc. The specimen figured by Keeping as *P. atavus* is in the collection of Mr. J. F. Walker. The types of *P. ornithopus* are in the Woodwardian Museum.

Distribution.—Lower Greensand of Upware and Faringdon. Ferruginous Sands of Shanklin.

¹ 'Foss. Corall. Valang. et Urgon. de Mt. Salève' (1866), p. 65, pl. E, fig. 9. Also in A. Favre, 'Rech. géol. dans Savoie,' vol. i (1867), p. 390, pl. C, fig. 27.

² 'Foss. Terr. Crét. Ste. Croix' (1870), p. 242, pl. clxxxi, figs. 1—3.

PECTEN (NEITHEA) COMETA (*d'Orbigny*), 1847. Plate XXXIX, figs. 6—10.

1847.	JANIRA COMETA,	A. <i>d'Orbigny</i> .	Pal. Franç. Terr. Crét., vol. iii, p. 640, pl. cccxlv, figs. 15—20.
1850.	—	—	Prodr. de Pal., vol. ii, p. 170.
1868.	—	A. Briart and F. L. Cornet.	Descript. Mineralog. Gêol. et Pal. de la Meule de Braquegnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 50, pl. iv, figs. 23, 24.
1870.	—	F. J. Pictet and G. Campiche.	Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 252.

Description.—Shell small, subtriangular, much higher than long, nearly equilateral. Antero- and postero-dorsal margins long; ventral margin very convex, with deep incisions between the main ribs. Ears very unequal; the anterior very long, the posterior small.

Right valve very convex, with a greatly incurved umbo, and five¹ very prominent angular ribs, which are crossed by numerous fine concentric ridges. The main ribs are separated by broad, deep, rounded depressions in which from three to seven slightly raised radial ribs occur; these small ribs are flattened and separated by narrow grooves, and bear numerous fine ridges placed transversely. At distant intervals from two to four strong growth-ridges may occur.

Left valve flattened, with five strong, rounded radial ribs separated by broad interspaces, both being crossed by fine concentric ridges. A few strong growth-ridges may occur.

Measurements :

	(1)	(2)	(3)	(4)	(5)
Length . . .	14	13.5	11	10	11 mm.
Height . . .	18	19	14.5	13	16 „

(1, 2) Cenomanian, Wilmington.

(3, 4) Upper Greensand, Warminster.

Affinities.—This species is closely allied to *Janira longicauda*, *d'Orbigny*,² but is distinguished from it by the main ribs being narrower and more angular. It is also nearly related to *P. notabilis*, Goldfuss,³ but differs in possessing five main ribs instead of six, and apparently also in being relatively higher.

¹ Occasionally a sixth rib, not quite so prominent as the others, occurs near the anterior margin.

² 'Pal. Franç. Terr. Crét.,' vol. iii (1847), p. 639, pl. cccxlv, figs. 9—14. Geinitz, "Das Elbthalgeb. in Sachsen" ('Palaeontographica,' vol. xx, pt. 1, 1872), p. 202, pl. xlv, figs. 16, 17.

³ 'Petref. Germ.,' vol. ii (1833), p. 56, pl. xciii, fig. 3. Geinitz, "Das Elbthalgeb. in Sachsen" ('Palaeontographica,' vol. xx, pt. 1, 1872), p. 202, pl. xlv, figs. 10—12.

It is difficult to separate *Janira Johannis Boehmi*, Tiessen,¹ from *P. (N.) cometa*, since in the latter the symmetry (depending on the position of the middle rib) varies in different specimens.

P. (Neithea) cometa also presents some resemblance to the smaller forms of *P. (N.) atavus*, but is distinguished by possessing five (instead of six) main ribs, by being relatively higher, and by having the right valve more convex.

Remarks.—This appears to be a relatively rare species. A specimen from the Cenomanian of Saint Jouin (Seine-Inférieure) has been sent me by M. Fortin, and agrees perfectly with the English examples.

Types.—D'Orbigny's specimens came from the Cenomanian of Villers (Calvados) and Le Havre (Seine-Inférieure).

Distribution.—Upper Greensand (zone of *Pecten asper*) of the Isle of Wight, Maiden Bradley, Melcombe Bingham (Dorset), south-west of Armswell Farm (Dorset), and west of Melbury Hill (Dorset). Rye Hill Sands of Warminster. Chloritic Marl of Ventnor and Maiden Bradley. Cenomanian of Wilmington.

PECTEN (NEITHEA) MORRISI (*Pictet and Renevier*), 1858. Plate XXXIX, figs. 11a—c, 12a, b, 13.

- ‡ 1841. PECTEN QUINQUECOSTATUS, var. a, *F. A. Römer*. Die Verstein. d. nord-deutsch. Kreidegeb., p. 54.
1845. — — — *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 249 (*partim*).
1846. — VERSICOSTATUS, *A. Leymerie*. Statist. géol. et min. du départ. de l'Aube, Atlas, p. II, pl. vi, fig. 9.
1847. — QUINQUECOSTATUS, var., *J. Morris*. Quart. Journ. Geol. Soc., vol. iii, p. 295 (foot-note).
1853. JANIRA QUINQUECOSTATA, *F. J. Pictet and W. Roux*. Moll. Foss. Grès verts de Genève, p. 506, pl. xlv, figs. 3 a, b (not c).
1858. — MORRISI, *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 128, pl. xix, fig. 2.
- ‡ 1859. — QUINQUECOSTATA, *J. Vilanova y Piera*. Mem. geogn.-agric. de Castellon, pl. iii, fig. 23.
1865. — MORRISI, *H. Coquand*. Mon. Aptien de l'Espagne, p. 151.
1870. — — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 244.
1887. — — — *L. Mallada*. Sinops. Espec. Fós. España, vol. iii, Crét. infer. (Bolet. Com. Mapa geol. España, vol. xiv), p. 130.

¹ 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. xlvii (1895), p. 473, pl. xvii, fig. 5.

1901-2. VOLA MORRISI, *P. Choffat*. Faune Crét. du Portugal, vol. i, ser. 4, p. 147, pl. iii, figs. 5, 6.

Non 1883. PECTEN (NEITHEA) MORRISI, *W. Keeping*. Foss., etc., Neoc. Upware and Brickhill, p. 106 (= *quinquecostatus*).

Remarks.—The forms found in the lower part of the Lower Greensand are very closely related to *Pecten* (*Neitheia*) *quinquecostatus*, but show, in general, certain small differences from the latter, so that it will, I think, be convenient to retain for them the name *Morrisi*, given by Pictet and Renevier.

As a rule *P. (N.) Morrisi* is characterised by the relatively greater height of the shell (and consequently smaller apical angle), by the smaller convexity of the right valve, the rather stronger main ribs, with the ribs of the interspaces rather more unequal in size, and lastly in having the areas,¹ as a rule, without ribs. The concentric ornamentation agrees with that of *P. (N.) quinquecostatus*.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Length .	28	. 27	. 19	. 15	. 17	. 23	. 19 mm.
Height .	34.5	. 34	. 23	. 19	. 19.5	. 28	. 25 ,,

(1—4) *Perna*-bed, Atherfield.

(5, 6) Hythe Beds, Lympne.

(7) Crackers, Atherfield.

Distribution.—*Perna*-bed and Crackers of Atherfield. Hythe Beds of Lympne.

PECTEN (NEITHEA) QUINQUECOSTATUS, *Sowerby*, 1814. Plate XXXIX, figs. 14—17;
Plate XL, figs. 1—5.

1814. PECTEN QUINQUECOSTATA, *J. Sowerby*. Min. Conch., vol. i, p. 122, pl. lvi, figs. 4—8.

1819. — VERSICOSTATUS, *Lamarck*. Anim. sans Vert., vol. vi, p. 181.

1822. — QUINQUECOSTATUS, *A. Brongniart*. Descript. géol. env. de Paris. In *Cuvier's Ossem. Foss.*, ed. 2, vol. ii, pp. 251, 320, 332, 600, pl. iv, fig. 1.

— QUINQUECOSTATA, *G. Mantell*. Foss. S. Downs, pp. 128, 201, pl. xxvi, figs. 14, 19, 20.

1824. NEITHEA VERSICOSTATA, *C. Drouet*. Mém. Soc. Linn. de Paris, vol. iii, p. 187, pl. vii, fig. 4.

1825. PECTEN VERSICOSTATUS, *DeFrance*. Dict. Sci. nat., vol. xxxviii, p. 254.

1827. — QUINQUECOSTATUS, *S. Nilsson*. Petrif. Suecana, p. 19, pl. ix, fig. 8; pl. x, fig. 7.

¹ This term in this sub-genus refers to the parts of the right valve between the outermost main ribs and the antero- and postero-dorsal margins.

1832. PECTEN VERSICOSTATUS, *Bruguère*. Hist. nat. des Vers et des Mollusques (Encyc. méthod.), vol. iii, p. 727, pl. ccxiv, fig. 10.
1833. — QUINQUECOSTATUS, *A. Goldfuss*. Petref. Germ., vol. ii, p. 55, pl. xciii, fig. 1.
1834. — — *S. G. Morton*. Synops. Org. Remains Cret. U.S., p. 57, pl. xix, fig. 1.
1836. — VERSICOSTATUS, *Lamarek*. Anim. sans Vert. (ed. 2 by Deshayes and Milne-Edwards), vol. vii, p. 158.
- ? — — QUINQUECOSTATUS, *S. G. Morton*. Amer. Journ. Sci., vol. xviii, p. 250, pl. iii, fig. 5.
1837. — VERSICOSTATUS, *F. Dujardin*. Mém. Soc. géol. France, vol. ii, p. 227.
- — QUINQUECOSTATUS, *H. G. Brown*. Lethæa Geogn., p. 678, pl. xxx, fig. 17.
- — — *W. Hisinger*. Lethæa Suecica, p. 50, pl. xvi, fig. 2.
- — — *A. d'Archiac*. Mém. Soc. géol. de France, vol. ii, p. 186.
1839. — — *H. B. Geinitz*. Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. I, p. 22.
1841. — — var. β , *F. A. Römer*. Die Verstein. nord-deutsch. Kreidegeb., p. 54.
1846. — — *E. Forbes*. Trans. Geol. Soc., ser. 2, vol. vii, p. 153.
- — — *H. B. Geinitz*. Grundr. der Verstein., p. 470.
- — (NEITHEA) VERSICOSTATUS, *A. E. Reuss*. Die Verstein. der böhm. Kreideformat., pt. 2, p. 31 (? *partim*).
1847. JANIRA QUINQUECOSTATA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 632, pl. ccxciv, figs. 1—5.
- ? — PECTEN (NEITHEA) QUINQUECOSTATUS, *J. Müller*. Petref. Aachen. Kreideformat., pt. I, p. 33.
- JANIRA FONTANIERI, *A. d'Orbigny*. Voy. au Pole Sud dans l'Océanie sur les corvettes l'Astrolabe et la Zélée. Atlas, pl. vii, figs. 38—40.
1850. PECTEN QUINQUECOSTATUS, *J. de C. Sowerby*, in *F. Dixon*. Geol. Sussex, p. 356 (p. 386, ed. 2), pl. xxviii, figs. 1—3.
- JANIRA QUINQUECOSTATA, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 169.
- — FONTANIERI, *d'Orbigny*. Ibid., p. 253.
- PECTEN (NEITHEA) QUINQUECOSTATUS, *H. B. Geinitz*. Das Quadersandst. oder Kreidegeb. in Deutschland, p. 186.
- 1851—2. NEITHEA QUINQUECOSTATA, *H. G. Brown*. Lethæa Geogn., ed. 3, vol. ii, pt. 5, p. 275, pl. xxx, fig. 17.
1854. PECTEN QUINQUECOSTATUS, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 177.
- — ÆQUICOSTATUS, *Morris*. Ibid., p. 177 (*partim*).

1855. PECTEN QUINQUECOSTATUS, *W. H. Baily*. Quart. Journ. Geol. Soc., vol. xi, p. 462.
- JANIRA QUINQUECOSTATA, *G. Cotteau*. Moll. Foss. de l'Yonne, p. 117.
1863. PECTEN QUINQUECOSTATUS, *A. Kunth*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 725.
1870. JANIRA QUINQUECOSTATA, *F. Römer*. Geol. von Oberschles., p. 340.
- — — *C. Schlüter*. Neues Jahrb. für Min., etc., pp. 937, 951.
- — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 246.
1871. VOLA QUINQUECOSTATA, *F. Stoliczka*. Palæont. Indica, Crét. Fauna S. India, vol. iii, p. 437, pl. xxxi, figs. 1—6; pl. xxxiv, figs. 4—9.
1872. — — — *H. B. Geinitz*. Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 201, pl. xlv, figs. 8, 9; pt. 2, p. 36, pl. x, figs. 17, 18.
1877. — — — *A. Fritsch*. Stud. im Gebiete der böhm. Kreideformat.: II, Die Weissenberg. und Malnitz. Schicht., p. 137.
- NEITHEA QUINQUECOSTATA, *W. M. Gabb*. Journ. Acad. Nat. Sci. Philad., ser. 2, vol. viii, pt. 3, p. 294.
1878. — — — *E. Bayle*. Explie. Carte géol. France, vol. iv, Atlas, pt. i, pl. cxvii, figs. 2, 3.
1882. VOLA QUINQUECOSTATA, *H. Schröder*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 271.
1883. PECTEN (NEITHEA) MORRISI, *W. Keeping*. Foss., etc., Neoc. Upware and Brickhill, p. 106.
- — — *ATAVA, Keeping*. Ibid., p. 107, pl. iv, fig. 6.
- VOLA QUINQUECOSTATA, *A. Fritsch*. Stud. im Gebiete der böhm. Kreideformat.: III, Die Iserschicht., p. 116, fig. 90.
1885. JANIRA QUINQUECOSTATA, *F. Nölling*. Die Fauna d. baltisch. Cenoman. (Palæont. Abhandl., vol. ii), p. 21.
1889. VOLA QUINQUECOSTATA, *K. Martin*. Die Fauna der Kreideformat. v. Martapocera (Samml. Geol. Reichs-Museum in Leiden, vol. iv), p. 157, pl. xvi, figs. 10, 11.
- *A. Fritsch*. Stud. im Gebiete der böhm. Kreideformat.: IV, Die Teplitz. Schicht., p. 85.
- cf. QUINQUECOSTATA, *E. Holzappel*. Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 238.
1890. — — — *M. Blanckenhorn*. Beitr. z. Geol. Syriens. Entwickel. d. Kreidesyst. in Mittel und Nord-Syrien, p. 77.
- 1890-91. PECTEN QUINQUECOSTATUS, *A. Peron*. Moll. Foss. Terr. Crét. de la Tunisie (Explor. Scient. de la Tunisie), pt. 2, p. 227.

1893. JANIRA (VOLA) QUINQUECOSTATA, *R. Michael*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 237.
1895. — QUINQUECOSTATA, *E. Tiessen*. Ibid., vol. xlvii, p. 471.
1896. VOLA QUINQUECOSTATA, *A. Ratot*. Bull. Soc. Belge de Géol., etc., vol. x, p. 30.
1897. — — — *U. Sohle*. Geogn. Jahresh. (1896), p. 40.
- — — *R. Leonhard*. Kreideformat. in Oberschles. (Palaeontographica, vol. xlv), p. 46.
- — — *A. Hennig*. Revis. af Lamellibr. i Nilsson's 'Petrif. Suecana Form. Cret.' (Kon. Fysiogr. Sällsk. i Lund. Handl., N. F., vol. viii), p. 52.
- ? 1900. — — — *G. Müller*. Verstein. des Jura u. d. Kreide. (Deutsch-Ost-Afrika, vol. vii), p. 565, pl. xxiv, fig. 1.
1901. — — — *H. Imkeller*. Die Kreidebild. Stallauer Eck u. Enzenauer Kopf (Palaeontographica, vol. xlviii), p. 32.
- 1901-2. — — — *P. Choffat*. Faune Crét. Portugal, vol. i, ser. 4, p. 148, pl. iii, fig. 7.
1902. — — — *J. P. J. Ravn*. Mollusk. i Danmarks Kridtafl. I. Lamellibr. (D. Kgl. Danske vid. Selsk. Skrift. 6 Række, nat. og math., vol. xi), p. 95.
- Non 1850. PECTEN QUINQUECOSTATUS, *R. Kner*. Verstein. Kreidemerg. von Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii), p. 29 (? = *striatocostatus*).

Description.—Shell ovate or somewhat triangular, nearly equilateral; height sometimes equal or nearly equal to, but usually rather greater than, the length.

Right valve moderately convex, with incurved umbo, and strong, rounded, regular ribs. Six main ribs are rather larger than the others, and project at the margin of the valve, forming angles between which the parts of the margin are slightly concave; the anterior and posterior main ribs are not quite so strong as the others. The interspaces between the main ribs are flattened or sometimes slightly concave; in the larger number of cases four ribs occur in each interspace, but occasionally there are three, five, or six ribs in one or more of the interspaces—not infrequently the interspace next the posterior area has five ribs. The two middle ribs of the interspaces are commonly rather stronger than one or both of the laterals; sometimes one lateral is very small. The grooves between the ribs are usually narrower than the ribs. Posterior area slightly larger than the anterior; both with ribs which are smaller than those on the rest of the shell; the anterior usually with from four to eight, the posterior with from five to eight ribs. Both ribs and grooves are crossed by numerous fine, regular, concentric

ridges, which run parallel with the margin of the shell and with the growth-ridges. Ears small or of moderate size, triangular, slightly unequal, with small radial ribs.

Left valve slightly concave or nearly flat; length greater than height. Ribs narrow, rounded, separated by broader grooves; six of the latter (corresponding in position with the main ribs of the right valve) are broader than the others. The ribs vary in number from twenty-seven to thirty-five, with also a few very small ribs near the anterior and posterior margins. Concentric ornamentation similar to that on the right valve. Ears triangular, nearly equal, with faint radial ribs.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Length .	23	30	21	15	11	35	17	32	22	17	19	17	48	33	30	26	22	23	21	20
Height .	27	34	26	19	13	35	19	35	26	20	22	19	52	37	35	30	26	27	24	22.5
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)			
Length .	17	11	25	23	19	32	28	20	27	34	32	...	31	32	17	34	39	39	mm.	
Height .	20	14	28	26	22	33	33	20.5	30	35	35	...	29	28	16	30	37	33	mm.	
	(1—31) Right valves.										(32—37) Left valves.									

(1—31) Right valves. (32—37) Left valves.

(1, 2) Lower Greensand, Upware.

(3—5) „ „ Faringdon.

(6—12) Upper Greensand (zone of *Pecten asper*): (6, 7) Shaftesbury; (8) Warminster;

(9—11) Ventnor; (12) Haldon.

(13—22) Cenomanian, Wilmington.

(23—25) „ „ Devon Coast (Dunscombe and Branscombe).

(26) Upper Chalk (? *M. cor-anguinum* zone), Gravesend.

(27) „ „ Brighton.

(28) „ „ (? *M. cor-anguinum* zone), Gravesend.

(29) „ „ (*M. cor-anguinum* zone), Charlton.

(30) „ „ „ „ Gravesend.

(31) „ „ „ Lewes.

(32) Upper Greensand, Warminster.

(33) Upper Chalk (? *M. cor-anguinum* zone), Gravesend.

(34) Upper Greensand, Shaftesbury.

(35—37) Upper Chalk (*M. cor-anguinum* zone), Gravesend.

Affinities.—See *P. (N.) Morrisi* (p. 202), *quadricostatus* (p. 210), *xquicostatus* (p. 209), *seccostatus* (p. 214).

The specimens from the Lower Greensand of Upware, which were referred by W. Keeping to *P. (N.) Morrisi* (see p. 201), agree perfectly in form, in the regularity of the ribs, and in the occurrence of ribs on the areas with *P. (N.) quinquocostatus* and should, I think, be referred to that species.

Remarks.—This species varies to some extent in the convexity of the right valve and in the relative proportions of length and height, but these variations seem to be connected with local conditions only. The specimens from the Upper

Greensand of Ventnor are rather more convex than usual; those from the Upper Greensand of Warminster are, as a rule, less convex and rather longer. Other modifications are seen in the strength of the main ribs, the flatness or slightly concave character of the interspaces, the number of ribs in the interspaces and the amount of their inequality, and the length of the hinge-line, which is correlated with the slope of the anterior and posterior areas.

In some specimens from the Upper Chalk (Plate XL, fig. 2) the main ribs are rather stronger than usual, the intermediate ribs more unequal, and the hinge-line shorter; but such forms can be matched with some of those found in the Cenomanian of Devon and France, whilst other Upper Chalk specimens belong to the type which is common in the Upper Greensand of Warminster and the Cenomanian of the Devon coast and France.

The specimens figured by Mantell were regarded by d'Orbigny as distinct from *Pecten quinquecostatus*, Sowerby, and were referred by him to *Janira Dutemplei*. Peron adopts the same view, and moreover refers the first two of Sowerby's figures (figs. 4, 5) to *P. Dutemplei*, and regards the Upper Greensand form as distinct. An examination of a number of specimens from the Upper Chalk shows, however, that whilst there is some variation, yet they are inseparable from the Upper Greensand form, and that they differ from *P. Dutemplei* (see p. 216). Morris also appears to have regarded the Warminster specimens as distinct from those found in the Chalk; the latter he referred to *P. quinquecostatus*, and the former to *P. æquicostatus*; but the Warminster form figured by Sowerby is certainly distinct from *P. æquicostatus*, Lamarck. A typical form of *P. quinquecostatus* from the Cenomanian of Rouen is figured by Bayle, and similar specimens from that and other French localities have been sent me by M. Raoul Fortin of Rouen. In some Cenomanian specimens the main ribs are not so strong as usual; such forms make some approach to *P. æquicostatus*, but can be easily distinguished by their well-marked concentric ridges.

Types.—In the British Museum; figs. 4, 5, from the Chalk of Lewes; figs. 6—8 from the Rye Hill Sand of Chute Farm, Warminster. Mantell's figured specimens appear to have been lost.

Distribution.—Lower Greensand of Faringdon and Upware. Folkestone Beds of Folkestone.

Upper Greensand (zone of *Schænbachia rostrata*) of Blackdown; malmsone of Devizes and the Isle of Wight. Upper Greensand (zone of *Pecten asper*) of Haldon, Cheddington (Dorset), Ball Wood (Dorset), Shaftesbury, Warminster, Ventnor, and Niton.

Rye Hill Sand of Warminster. Chloritic Marl of Maiden Bradley. Cenomanian (Meyer's Beds 10 and 12) of Dunscombe and (Bed 11) of Branscombe and Whitecliff. Cenomanian Sandstone of Wilmington. *T. gracilis* zone of Dover

(*vide* Rowe). *H. planus* zone of Dover and the Sussex coast (*vide* Rowe). *M. cor-testudinarium* zone of Seaford, Chatham, and Purley. *M. cor-anguinum* zone of Mitcheldever (Hants), Broadstairs, Charlton, Northfleet, and Gravesend. *Marsupites* zone of Brighton and Margate. *A. quadratus* zone of Brighton, Paulsgrove (Hants), and West Harnham (Salisbury). Upper Chalk of Lewes.

PECTEN (NEITHEA) ÆQUICOSTATUS, *Lamarck*, 1819. Plate XL, figs. 8 *a*, *b*, 9 *a*—*c*.

1819. PECTEN ÆQUICOSTATUS, *Lamarck*. Anim. sans Vert., vol. vi, p. 181.
 1824. NEITHEA PECTINOIDES, *C. Drouet*. Mém. Soc. Linn. de Paris, vol. iii, p. 186, pl. vii, figs. 1, 2.
 1825. PECTEN ÆQUICOSTATUS, *Defrance*. Dict. Sci. nat., vol. xxxviii, p. 255.
 1833. — — — *A. Goldfuss*. Petref. Germ., vol. ii, p. 54, pl. xcii, fig. 6.
 1836. — — — *Lamarck*. Anim. sans Vert., ed. 2 (by Deshayes and Milne-Edwards), vol. vii, p. 158.
 1839. — — — *H. B. Geinitz*. Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 22.
 1841. — — — *F. A. Römer*. Verstein. nord-deutsch. Kreidegeb., p. 54.
 1846. — — — *H. B. Geinitz*. Grundr. der Verstein., p. 469.
 — — — *A. E. Reuss*. Die Verstein. der böhm. Kreideformat., pt. 2, p. 32, pl. xxxix, fig. 22; pl. xl, figs. 2, 3.
 ? 1847. JANIRA ÆQUICOSTATA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 637, pl. ccccxlv, figs. 1—4.
 1850. — — — ÆQUICOSTATA, *d'Orbigny*. Prodr. de Pal., vol. ii, p. 170.
 — — — PECTEN ÆQUICOSTATUS, *H. B. Geinitz*. Das Quadersandst. oder Kreidegeb. in Deutschland, p. 186.
 1854. — — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 175 (*partim*).
 1863. — — — *A. Kunth*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 725.
 1868. JANIRA ÆQUICOSTATA, *A. Briart and F. L. Cornet*. Descript. Mineralog. Géol. et Pal. de la Meule de Bracquagnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 49, pl. iv, figs. 25, 26.
 1872. VOLA ÆQUICOSTATA, *H. B. Geinitz*. Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 200, pl. xlv, figs. 5—7.
 ? 1876. PECTEN ÆQUICOSTATUS, var. LONGICOLLIS, *H. Deicke*. Die Tourtia von Mülheim a. d. Ruhr. (Beitr. z. geogn. u. pal. Beschaffenh. d. unt. Ruhrgegend. Beitr. I), p. 26.

1878. *NEITHEA* *ÆQUICOSTATA*, *E. Bayle*. Explic. de la Carte géol. de France, vol. iv, pt. 1 (Atlas), pl. cxxii, fig. 4.
1882. *JANIRA* *ÆQUICOSTATA*, *P. de Loriol*. Gault de Cosne (Mém. Soc. Pal., Suisse, vol. ix), p. 102, pl. xiii, figs. 6—8.
1885. — — — *F. Nödling*. Die Fauna d. baltisch. Cenoman. (Palæont. Abhandl., vol. ii), p. 21.
1893. — (*VOLA*) *ÆQUICOSTATA*, *R. Michael*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 237.
1894. *VOLA* *ÆQUICOSTATA*, *A. Hennig*. Om Åhussandst. (Geol. Fören. i Stockholm Förhandl., vol. xvi), p. 520.
1895. *JANIRA* *ÆQUICOSTATA*, *E. Tiessen*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xlviii, p. 472.
- 1901-2. *VOLA* *ÆQUICOSTATA*, *P. Choffat*. Faune Crét. Portugal, vol. i, ser. 4, p. 152, pl. iii, fig. 10.
- ? Nov 1847. *PECTEN* *ÆQUICOSTATUS*, *J. Müller*. Petref. Aachen. Kreideformat., pt. 1, p. 33.
- Nov 1850. — — — *J. de C. Sowerby*. In *F. Dixon's* Geol. Sussex, p. 356, pl. xxviii, figs. 17, 18 (= *sexcostatus*).

Description.—Shell ovate, equilateral; ventral margin very convex and rounded; antero- and postero-dorsal margins slightly concave.

Right valve very convex, with a prominent incurved umbo, and with from thirty-four to forty-four rather small, rounded ribs of nearly equal size, except those near the anterior and posterior margins, which are smaller. The ribs are separated by rounded furrows of about the same width as the ribs. Both ribs and furrows are smooth, or nearly smooth. Near the antero- and postero-dorsal margins are narrow, smooth areas without ribs, the anterior area being slightly smaller than the posterior. Ears of moderate size, triangular, nearly equal, smooth, or with fine concentric ridges.

Left valve flat or slightly concave, with ribs similar to those of the right valve.

Measurements:

	(1)	(2)	(3)
Length .	14	10.5	9 mm.
Height .	16	12	11 "
(1, 3) Upper Greensand (zone of <i>Pecten asper</i>), Haldon.			
(2) " " " " " Worbarrow.			

Affinities.—This species is distinguished from *P. (Neithea) quinquecostatus* by the ribs being of equal size, and smooth or nearly smooth; also by the ventral margin of the shell being evenly rounded and by the areas being without ribs. D'Orbigny's figure shows six more prominent ribs, but I have seen faint indications

of such ribs in only a few specimens. A typical form is figured by Bayle; it agrees perfectly with specimens from the Cenomanian of Rouen and Orbiquet which have been sent me by M. Fortin, and with others from the Cenomanian of Le Havre, sent by M. A. de Grossouvre.

Remarks.—Morris referred the specimens from the Upper Greensand, which Sowerby figured as *P. quinquecostatus* (figs. 6—8), to this species, but they are clearly distinguishable by the presence of six main ribs, and by the concentric ornamentation.

Types.—Lamarck's types came from the Cenomanian of Le Mans, and from near Angers. Goldfuss' specimens came from the Quader-sandstone near Dresden, and the Greensand of Regensburg.

Distribution.—Upper Greensand (Chert Beds, zone of *Pecten asper*) of Haldon, of Worbarrow, and Warminster. Chloritic Marl of Maiden Bradley.

PECTEN (NEITHEA) QUADRICOSTATUS, *Sowerby*, 1814. Plate XL, figs. 6, 7. Text-figs. 3—5.

1806. (Figure without name), *J. Sowerby*. British Mineralogy, vol. ii, p. 159, pl. clxxxiii.
1814. PECTEN QUADRICOSTATA, *Sowerby*. Min. Conch., vol. i, p. 122, pl. lvi, figs. 1, 2.
1833. — QUADRICOSTATUS, *A. Goldfuss*. Petref. Germ., vol. ii, p. 54 (*partim*), pl. xcii, fig. 7.
1837. — QUADRICOSTATA, *H. G. Bronn*. Lethæa Geogn., p. 680, pl. xxx, fig. 16.
1839. — QUADRICOSTATUS, *H. B. Geinitz*. Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 1, p. 22.
1841. — — *F. A. Römer*. Verstein. des nord-deutsch. Kreidegeb., p. 54.
1843. — — *H. B. Geinitz*. Die Verstein. von Kieslingswalda, p. 16, pl. iii, figs. 14, 15.
1846. — — *Geinitz*. Grundriss der Verstein., p. 469.
- ? — — VERSICOSTATUS, *A. E. Reuss*. Die Verstein. der böhm. Kreide-format., pt. 2, p. 31 (? *partim*).
1850. JANIRA GEINITZII, *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 197.
- 1850–51. NEITHEA QUADRICOSTATUS, *H. G. Bronn*. Lethæa Geogn., ed. 3, vol. ii, pt. 5, p. 277, pl. xxx, fig. 16.
1853. JANIRA FAUCIGNYANA, *F. J. Pictet and W. Roux*. Moll. Foss. Grès verts de Genève, p. 505, pl. xlv, fig. 2.
1854. PECTEN QUADRICOSTATUS, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 177.
1863. — — *A. Kunth*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 725.

1868. JANIRA QUADRICOSTATA, *A. Briart and F. L. Cornet*. Descript. Mineralog. Géol. et Pal. de la Meule de Bracquagnies (Mém. cour. et Mém. des Sav. étrangers, vol. xxxiv), p. 48, pl. iv, figs. 21, 22.
1870. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), pp. 249, 251.
- ? — PECTEN QUADRICOSTATUS, *H. Credner*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xxii, p. 232.
1871. VOLA QUADRICOSTATA, *F. Stoliczka*. Palaont. Indica, Crét. Fauna S. India, vol. iii, p. 430.
1872. — — *H. B. Geinitz*. Das Elbthalgeb. in Sachsen (Palaeontographica, vol. xx, pt. 2), p. 37, pl. x, figs. 14—16.
1874. JANIRA QUADRICOSTATA, *W. Dames*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xxvi, p. 765.
- ? 1881. — — *J. Kiesow*. Schrift. nat. Gesellsch. in Danzig, N. F., vol. v, p. 414.
- ? 1882. — — — Ibid., vol. v, p. 240.
- ? — — *P. de Loriol*. Gault de Cosne (Mém. Soc. Pal. Suisse, vol. xii), p. 103, pl. xiii, fig. 4.
1895. — — *E. Tiessen*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvii, p. 472.
- ? 1897. VOLA QUADRICOSTATA, *U. Schüle*. Geogn. Jahresh. (1896), p. 39.
- Non 1847. PECTEN QUADRICOSTATUS, *J. Müller*. Petref. Aachen. Kreideformat., pt. 1, p. 33.
- — JANIRA QUADRICOSTATA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 644, pl. cccclvii, figs. 1—7 (= *Faujasi*, Pict. and Camp.).
- 1850. — — *A. Alth.* Geog.-pal. Beschreib. von Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii), p. 249.
- — — *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 253.
- 1852. PECTEN QUADRICOSTATUS, *F. Römer*. Kreidebild. von Texas, p. 64, pl. viii, fig. 4.
- ? — — — *R. Kner*. Kreideverstein. von Ost-Galizien (Denkschr. d. k. Akad. Wissensch. Math.-nat. Classe, vol. iii), p. 317.
- ? — 1854. — — *A. d'Archiac*. Bull. Soc. géol. de France, ser. 2, vol. xii, p. 215, pl. iii, fig. 10.
- 1866. JANIRA QUADRICOSTATA, *K. A. Zittel*. Die Biv. der Gosaugeb. (Denkschr. d. k. Akad. Wissensch. Math.-nat. Classe, vol. xxv), pt. 2, p. 115, pl. xviii, fig. 4.

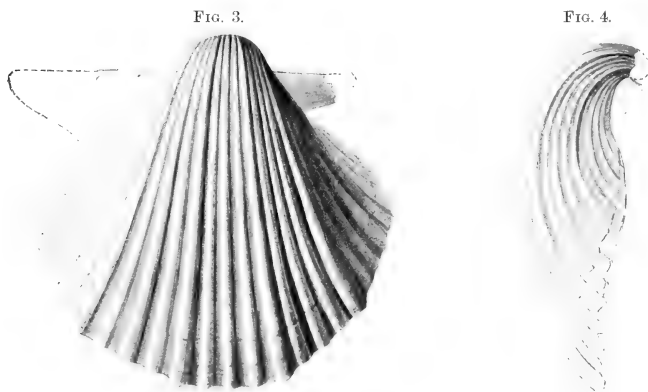
- Non. 1869. *JANIRA QUADRICOSTATA*, *E. Favre*. Moll. Foss. de la Craie de Lemberg, p. 155.
- 1876. *VOLA QUADRICOSTATA*, *D. Brauns*. Senon. des Salzberges (Zeitschr. f. d. gesamt. Naturwiss., vol. xvi), p. 388.
- 1877. *JANIRA QUADRICOSTATA*, *A. Peron*. Bull. Soc. géol. de France, ser. 3, vol. v, p. 502.
- 1889. *VOLA QUADRICOSTATA*, *E. Holzapfel*. Die Mollusk. Aachen. Kreide (Paläontographica, vol. xxxv), p. 237, pl. xxvi, fig. 20.
- — — — *O. Griepkerl*. Senon. von Königslutter (Paläont. Abhandl., vol. iv), p. 48.
- 1892. *NEITHEA QUADRICOSTATA*, *K. Futterer*. Kreidebild. des Lago di Santa Croce (Paläont. Abhandl., vol. vi), p. 80, pl. iii, fig. 6.
- 1894. *VOLA QUADRICOSTATA*, *A. Hennig*. Om Åhussandst. (Geol. Fören. i Stockholm Förhandl., vol. xvi), p. 520.
- — — — *B. Lundgren*. Mollusk-faunan i Mammillat. och Mucronata zonerna (K. Svenska Vet.-Akad. Handl., N. F., vol. xxvi, No. 6), p. 44.
- 1895. — — — *F. Vogel*. Holländisch. Kreide, p. 25.
- 1896. — — — *A. Rutot*. Bull. Soc. Belge de Géol., etc., vol. x, p. 30.
- 1901. — — — *H. Imkeller*. Kreidebild. am Stallauer Eck, etc. (Paläontographica, vol. xlvi), p. 31, pl. i, figs. 8, 9.

Description.—Shell large, ovate, rounded ventrally, more or less pointed dorsally, nearly equilateral; postero-dorsal a little longer than the antero-dorsal margin. Hinge-line long; ears large.

Right valve convex. Umbo prominent, incurved. Length of valve either equal to or slightly less than its height; greatest length at about the middle of the valve. Usually with twenty-one (occasionally twenty-four) ribs, which curve slightly outwards; all are strong and rounded, with slightly narrower furrows separating them. Six of the ribs are rather larger than the others, and project slightly at the ventral margin, forming angles, between which the margin of the valve is straight or slightly concave. The interspaces between the six main ribs are flattened, and in each, three (rarely four) smaller ribs occur; these are of nearly equal size, but the middle is sometimes slightly larger than the lateral. Occasionally this regularity in the ribs is partly lost owing to the stronger ribs being more numerous and the smaller ribs fewer than usual. Both ribs and furrows are crossed by numerous, very fine, regular concentric ridges, which are continued on to the areas. Antero- and postero-dorsal areas of fairly large size and sloping outwards—the former a little smaller than the latter. Antero-

dorsal area with four small radial ribs; postero-dorsal area with four or five (sometimes fewer) very small ribs. Ears very large and long, convex, with fine concentric ridges; the anterior with a sinus; the posterior larger than the anterior, with the outer angle acute, and usually with six faint radial ribs.

Left valve slightly concave or nearly flat, with a large apical angle; length greater than height, greatest length being above the middle line; usually with twenty-one rounded ribs of nearly equal size, separated by broader furrows, of which six—corresponding in position with the main ribs of the right valve—are



FIGS. 3 AND 4.—*Pecten (Neithca) quadricostatus*, Sow. Upper Greensand, Warminster. Woodwardian Museum. Natural size. Fig. 3, right valve; Fig. 4, anterior view of the same.

rather broader than the others. Antero- and postero-dorsal areas with small ribs. Ears very large, elongate, triangular, with very small radial ribs.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Length	74	67	67	66	63	52	78	71	56	58	57	36	71	58	49	33 mm.
Height	77	70	68	66	65	52	75	67	56	58	57	36	66	51	41	30 "

(1—12). Right valves :

(1—6) Upper Greensand, Warminster.

(7—9) Upper Greensand (zone of *P. asper*), Ventnor.

(10—12) " " (zone of *Schlenb. rostrata*), Blackdown.

(13—16). Left valves :

(13—15) Upper Greensand (zone of *Schlenb. rostrata*), Warminster.

(16) " " (zone of *P. asper*), Ventnor.

Affinities.—This species resembles *P. (Neithca) quinquecostatus*, but is of larger size, with usually only three ribs in each interspace, and with relatively larger ears and longer hinge-line.

A form found in the Senonian was described and figured by d'Orbigny as

Janira quadricostata, and many later writers have followed d'Orbigny in referring that form to Sowerby's species; but it was shown by Pictet and Campiche, and also by Briart and Cornet, that d'Orbigny's species is distinct from Sowerby's. The latter differs from the former in being of larger size, in having much larger ears and a longer hinge-line, in the anterior and posterior areas sloping outwards, in the larger apical angle (seen especially in the left valve), and in the greatest length of the left valve being above the middle line. The Senonian form figured by d'Orbigny was named *Janira Faujasi* by Pictet and Campiche,¹ and is regarded by Choffat² as identical with *regularis* of Schlotheim.

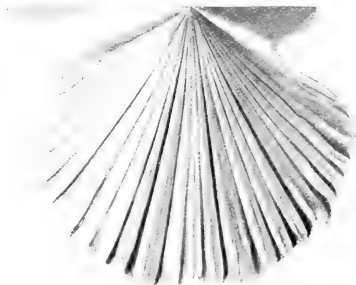


FIG. 5.—*Pecten (Neithea) quadricostatus*, Sow. Upper Greensand, Warminster. York Museum.
Interior of left valve. Natural size.

Types.—The specimens figured by Sowerby are in the British Museum—fig. 1 is from the Upper Greensand of Haldon, fig. 2 from the Upper Greensand of Chute Farm, Warminster. The example figured in the 'British Mineralogy' is from the Upper Greensand of Stourhead.

Distribution.—Upper Greensand (zone of *Schlaenbachia rostrata*) of Blackdown and the Isle of Wight; Upper Greensand (zone of *Pecten asper*) of Haldon, Cerne Abbas, Melcombe Bingham, Eggardon Hill, Maiden Newton, Ballard Down (Swanage), Warminster, and Ventnor.

PECTEN (NEITHEA) SEXCOSTATUS, *Woodward*, 1833. Plate XL, figs. 10—15; Plate
XLI, figs. 1—10.

? 1822. PECTEN QUINQUECOSTATA?, *G. Mantell*. Foss. S. Downs, p. 128, pl. xxv,
fig. 10.

? — — — — — *TRIPPLICATA*, *Mantell*. Ibid., p. 128, pl. xxv, fig. 9.

1833. — — — — — *SEXCOSTATUS*, *S. Woodward*. Geol. Norfolk, p. 48, pl. v, fig. 29.

¹ 'Foss. Terr. Crét. Ste. Croix' ('Matér. Pal. Suisse,' ser. 5, 1870), p. 253.

² 'Faune Crét. Portugal,' vol. i, ser. 4 (1901-2), p. 149.

1847. JANIRA DUTEMPLEI, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 646, pl. ccxcxvii, figs. 8—11.
1850. — — — — — Prodr. de Pal., vol. ii, p. 253.
- PECTEN AQUICOSTATUS, *J. de C. Sowerby*, in *F. Dizon*. Geol. Sussex, p. 356 (p. 386, ed. 2), pl. xxviii, figs. 17, 18.
1854. — SEXCOSTATUS, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 177.
1870. JANIRA DUTEMPLEI, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 253.
1877. — — — *A. Peron*. Bull. Soc. géol. France, ser. 3, vol. v, p. 507, pl. vii, figs. 4, 4 a.
1887. VOLA (JANIRA) DUTEMPLEI, *Peron*. L'Hist. Terr. Craie (Bull. Soc. Sci. hist. et nat. de l'Yonne, ser. 3, vol. xii), p. 164.
1889. — DUTEMPLEI, *O. Griepenkerl*. Senon. von Königsutter (Palaeont. Abhandl., vol. iv), p. 48.
1891. — — — *J. Böhm*. Die Kreidebild. des Fürbergs u. Sulzbergs (Palaeontographica, vol. xxxviii), p. 83, pl. iii, fig. 33.
1896. — — — ? *A. Rutot*. Bull. Soc. Belge de Géol., etc., vol. x, p. 31, fig. 14.
- ? 1901-2. — cf. DUTEMPLEI, *P. Choffat*. Faune Crét. Portugal, vol. i, ser. 4, p. 149, pl. iii, figs. 8, 9.

Description.—Form β (from the Upper Chalk, figs. 1—5). Shell ovately triangular, considerably higher than long, nearly equilateral. Ventral margin nearly semicircular, but with concave incisions of moderate depth between the main ribs. Both valves show well-marked growth-ridges at fairly distinct intervals. Hinge-line relatively short.

Right valve very convex, with six main ribs. Umbo greatly incurved and projecting beyond the level of the left valve. Antero- and postero-dorsal areas usually sloping inwards and concave. The six main ribs are usually prominent, and are separated by broad, concave, more or less deep interspaces. In the interspaces there are from four to seven¹ well-marked rounded ribs separated by furrows of about the same width; the central ribs are usually rather stronger than those at the sides (near the main ribs). The number of ribs in the interspaces varies in different specimens, and usually also in different interspaces of the same specimen; rarely four ribs are found in each interspace, less rarely five in each, but frequently five in four of the interspaces and six or seven in the remaining interspace, or the numbers in different interspaces may be four, five and six, or five, six and seven. The antero-dorsal area of this valve (*i. e.* the space between the anterior main rib and the anterior margin of the valve) bears from six to eight narrow ribs separated by broader furrows; these ribs are smaller than those in the interspaces

¹ Occasionally three or four very much smaller ribs are also present.

of the main ribs. On the postero-dorsal area from eight to twelve small ribs occur. Numerous fine, concentric, regular ridges are present on all the ribs; but the ridges in the furrows are less numerous and more widely separated than on the ribs, giving a ladder-like appearance. Ears nearly equal, triangular, of moderate size, with small radial ribs; the anterior ear more sharply marked off from the valve than the posterior ear.

Left valve flattened, sometimes slightly concave or slightly convex, with six main ribs which are less prominent than those on the right valve and are separated by shallow interspaces. At the summit of each main rib is a broad furrow. The ribs in the interspaces are narrow and separated by broader furrows; the number of ribs varies as on the right valve. Concentric ornamentation like that of the right valve. The antero- and postero-dorsal areas are narrow and bent at an angle with the rest of the valve; they bear small ribs. Ears nearly equal, with radial ribs.

Form α (from the Lower Chalk, figs. 6—10). The examples found in the Lower Chalk present some slight general differences from Form β . Thus (i) the margins between the main ribs are less concave, (ii) the growth-ridges are also less concave, (iii) the hinge-line is rather longer, and consequently the areas do not slope inwards, but, as a rule, slightly outwards, (iv) the convexity of the right valve seems, on the average, to be rather greater.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Length . .	16	14	13·5	6	21	20·5	19	18	17	16	15	15	15
Height . .	19	17	16	8	26	26	22	22	22	22	19	17·5	17
	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	
Length . .	13	10	16	15	13·5	13	12·5	10·5	8	15	14	11 mm.	
Height . .	17	13	19·5	17	17	15	14	14	9	19	15·5	13	„

(1—15) Form β . (16—25) Form α .

(1—3) *B. mucronata* zone, Norwich.

(4) „ „ Clarendon, Salisbury.

(5—15) *A. quadratus* zone, East Harnham, Salisbury.

(16—22) Chalk Marl, Folkestone.

(23—25) Totternhoe Stone, Burwell.

Affinities.—This species is distinguished from *P. (Neilhea) quinquecostatus* (see p. 202) by the following characters:—(1) the average size is much less; (2) on the right valve the main ribs are more prominent and the interspaces are more concave; (3) the ribs in the interspaces are less uniform in size; (4) the height of the shell is relatively greater; (5) generally the right valve is more convex and the umbo more sharply incurved; (6) the hinge-line is relatively shorter (especially in Form β); (7) the concentric ridges in the grooves are more

widely separated—in *P. quinquecostatus* these ridges are continued from the ribs across the grooves without change. See also *P. striato-costatus* (below).

Remarks.—The figure of *Pecten seacostatus* given by Woodward is not sufficiently good for exact determination, but specimens which have been obtained from the same locality as the type leave no doubt as to the identity of *P. seacostatus* with *Janira Dutemplei*, D'Orbigny.

The examples from the Lower Chalk are regarded by Peron as specifically inseparable from those found in the Upper Chalk, and with this view I agree, but since some slight differences are generally noticeable, I think it may be well to look on the examples from the Lower and Upper Chalk respectively as two forms or varieties of the same species, which may be referred to as Form *a* and Form *β*. A careful comparison of good series of specimens can scarcely leave any doubt on the mind as to the later forms having descended directly from the earlier. The examples found in the Gault probably also belong to Form *a*; they have, however, usually been referred to *P. (Neithea) quinquecostatus*.

The strength of the main ribs and the convexity of the right valve vary considerably in different specimens. There are also variations in the number of intermediate ribs, in their relative sizes, and in the depth of the incisions of the margin between the main ribs. In some examples from East Harnham the main ribs are unusually strong. In some of the larger specimens from Norwich the number of ribs near the margin of the valve is greater than usual owing to the introduction of small ribs in the grooves.

Types.—Woodward's type appears to have been lost. D'Orbigny's type of *Janira Dutemplei* came from the Senonian of Chavot (Marne).

Distribution.—Form *a*.—Chalk Marl of Dover, Folkestone, and Ventnor. Totternhoe Stone of Burwell. *H. subglobosus* zone of Cherry Hinton.

Form *β*.—*A. quadratus* zone of East Harnham (Salisbury) and Winchester. *B. mucronata* zone of Ballard Head (Dorset), Clarendon (Salisbury), and Norwich. Upper Chalk (? zone) of Brighton. Recorded by Rowe from the *M. cortestudinarium* and *M. cor-anguinum* zones of Thanet.

PECTEN (NEITHEA) STRIATOCOSTATUS, Goldfuss,¹ 1833. Plate XLI, figs. 9, 10.

A portion of a right valve and a nearly perfect left valve, which were found by

¹ 'Petref. Germ.,' vol. ii (1833), p. 55, pl. xciii, figs. 2 *c, d, e* (not 2 *a, b, f, g*); Favre, 'Moll. Foss. Craie de Lemberg' (1869), p. 156, pl. xiii, figs. 12, 13; Holzapfel, 'Moll. Aachen. Kreide' (1889), p. 239, pl. xxvi, fig. 19; Vogel, 'Holländisch. Kreide' (1895), p. 26; Müller, 'Mollusk. Unteren v. Braunschweig u. Ilse' (1898), p. 37; Ravn, 'Mollusk. i Danmarks Kridtstæfje' (1902), p. 95, pl. ii, figs. 8, 9; Wollermann, 'Fauna der Lüneburg. Kreide' (1902), p. 63.

Mr. Clement Reid in the Chalk of Trimmingham, probably belong to *P. (Neithea) striatocostatus*, Goldfuss. The six main ribs of the right valve are less prominent than in *P. (N.) sexcostatus*, and both these and the ribs in the interspaces bear two or three small, almost linear ribs, so that the total number of ribs on the valve becomes considerable; fine concentric ridges, similar to those of *P. (N.) sexcostatus*, are found in the grooves and sometimes pass on to the ribs. On the left valve the ribs are in pairs.

P. striatocostatus is found in the Senonian of Denmark, Aachen, Lemberg, etc.

Genus—VELOPECTEN, *Philippi*, 1898.

(*Zeitschr. d. deutsch. geol. Gesellsch.*, vol. 1, p. 597.)

VELOPECTEN STUDERI (*Pictet and Roux*), 1853. Plate XLI, fig. 11; Plate XLII, figs. 1—4.

- | | | |
|-------|---|--|
| 1853. | HINNITES STUDERI, <i>F. J. Pictet and W. Roux</i> . | Moll. Foss. Grès verts de Genève, p. 504, pl. xlv, fig. 1. |
| 1866. | — SALTERI, <i>H. G. Seeley</i> . | Ann. Mag. Nat. Hist., ser. 3, vol. xvii, p. 178. |
| 1870. | — STUDERI, <i>F. J. Pictet and G. Campiche</i> . | Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), pp. 232, 234, pl. clxxix. |
| 1875. | — — A. J. Jukes-Browne. | Quart. Journ. Geol. Soc., vol. xxxi, p. 296. |

Description.—Shell large, oval or nearly circular, somewhat inequilateral and irregular; height a little greater than length. Hinge-line long, sometimes almost equal to the length of the shell. Ears very unequal; the anterior left ear not distinctly separated from the rest of the valve.

Right valve flat, sometimes slightly concave, with more or less undulating surface. Radial ribs much more numerous, smaller, and closer together than on the left valve, alternately larger and smaller. Numerous growth-ridges cross the ribs, and produce a serrate appearance. Byssal sinus very deep; anterior ear very large.

Left valve convex, with a more or less undulating surface, ornamented with about fifteen primary ribs, which are narrow, strong, and slightly wavy, and are separated by broad, shallow interspaces; these ribs are prominent on the dorsal part of the valve, but become smaller on the ventral part, especially in large specimens. A secondary rib is usually introduced in the middle of each interspace, at varying distances from the umbo; and between this and the primary ribs on each

side other ribs (sometimes four or five) are introduced; these are usually smaller, and may be quite close together, but in old specimens they become widely separated ventrally. Both ribs and furrows are crossed by numerous fine, close-set, regular, concentric ridges. Anterior ear with about seven primary and seven secondary ribs. Posterior ear smaller and more distinctly limited.

Affinities.—*Hinnites Salteri*, Seeley, from the Red Limestone of Hunstanton, is founded on a portion of the left valve; it appears to me to be only a large example of *V. Studeri*, in which the main ribs are less prominent than usual owing to the abrasion of the shell. See also *V. trilinearis* (below).

Remarks.—The state of preservation of the examples of this species varies considerably, but is usually rather unsatisfactory. In the specimens from Warminster, where the species appears to be rare, the shell is preserved, and the ornamentation is very well shown, but in those from Folkestone the shell has usually disappeared. The examples from the Cambridge Greensand are internal casts in phosphate, in which there is no trace of the ears, and whilst some of the principal ribs are shown the details of the ornamentation are wanting. The specimens from the Red Limestone of Hunstanton are usually considerably larger than those from the Cambridge Greensand, and have the shell preserved in part at any rate; in some cases the fine ornamentation is clearly shown, but often it is indistinct owing to the outer layers of the shell having disappeared; in these large forms the main ribs become much less strong near the ventral margin, or, in some cases, almost indistinguishable.

Types.—From the Gault of the Perte du Rhône. The type of *Hinnites Salteri*, Seeley, from the Red Limestone of Hunstanton, is in the Woodwardian Museum, Cambridge.

Distribution.—Upper Gault (zone x) of Folkestone. Cambridge Greensand (derived from the Upper Gault). Red Limestone of Hunstanton. Upper Greensand of Warminster.

VELOPECTEN TRILINEARIS (*Seeley*), 1861. Plate XLII, fig. 5.

1861. HINNITES TRILINEARIS, *H. G. Seeley*. Ann. Mag. Nat. Hist., ser. 3, vol. vii, p. 119, pl. vi, fig. 2.

1866. — — — var., *Seeley*. Ibid., vol. xvii, p. 178.

Remarks.—The form named *Hinnites trilinearis* by Seeley was founded on a few imperfect specimens from the Cambridge Greensand. They seem to differ from the English examples of *V. Studeri* in having the primary ribs on the left valve stronger and more widely separated, but they approach very closely some of the specimens of that species figured by Pictet and Campiche, especially in having

small secondary ribs at the summits of the primary ribs. I have not sufficient material to enable me to decide whether or not *V. trilinearis* should be regarded as distinct from *V. Studeri*.

Type.—In the Woodwardian Museum.

Distribution.—Cambridge Greensand (derived from the Gault).

VELOPECTEN PECTINATUS (*Seeley*), 1861. Plate XLII, fig. 6.

1861. HINNITES PECTINATUS, *H. G. Seeley*. Ann. Mag. Nat. Hist., ser. 3, vol. vii, p. 119.

Remarks.—This form agrees with *V. trilinearis* in having very strong primary ribs, but seems to differ in that those ribs are more numerous and consequently closer together; the secondary ribs at the summits of the primaries also appear to be better marked, and are crossed by distinct concentric ridges.

Type.—In the Woodwardian Museum.

Distribution.—Cambridge Greensand (derived from the Gault).

VELOPECTEN, sp. Plate XLII, figs. 7, 8.

A few specimens from one of the nodule beds of the Gault of Folkestone agree with *V. trilinearis* (*Seeley*) in having relatively few main ribs on the left valve, and in the presence of secondary ribs at their summits, but the shell appears to be proportionately higher and shorter.

Genus—HINNITES, *DeFrance*, 1821.

(‘Dict. Sci. nat.’ vol. xxi, p. 169.)

HINNITES FAVRINUS, *Pictet and Roux*, 1853. Text-figs. 6, 7.

- | | | |
|-------|---|---|
| 1845. | HINNITES LEYMERII, <i>E. Forbes</i> (non <i>Deshayes</i>). | Quart. Journ. Geol. Soc.,
vol. i, p. 250. |
| 1853. | — FAVRINUS, <i>F. J. Pictet and W. Roux</i> . | Moll. Foss. Grès verts de
Genève, pp. 503, 547, pl. xliii,
fig. 2, pl. xlv. |
| 1854. | — LEYMERII, <i>J. Morris</i> . | Cat. Brit. Foss., ed. 2, p. 169. |
| 1858. | — FAVRINUS, <i>F. J. Pictet and E. Renevier</i> . | Foss. Terr. Aptien (Matér.
Pal. Suisse, ser. 1), p. 135. |
| 1865. | — — — <i>H. Coquand</i> . | Mon. Aptien de l’Espagne, p. 155. |

1870. HINNITES FAVRINUS, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 5), p. 231, pl. clxxviii.
1871. — — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 430.
1887. — — *L. Mallada*. Sinops. Espec. Fóss. España, vol. iii, Cret. infer. (Bolet. Mapa geol. España, vol. xiv), p. 131.

Description.—Shell very large and thick, irregularly oval or subcircular, with rounded margins; height sometimes equal to, but usually rather greater than the length. Hinge-line rather long; ears nearly equal.

Right valve convex, attached by a more or less large portion in the region of



FIG. 6.—*Hinnites Favrinus*, Pict. and Roux. *Perna*-bed, Atherfield. Museum of the Geological Society, No. 2022. Right valve. $\times \frac{1}{4}$.

the umbo; the unattached part has numerous broad, rounded, radial ribs of unequal size and sometimes bifurcated. Ribs with scale-like projections, and sometimes showing fine radial grooves. A few concentric lamellae or depressions, and also numerous fine growth-lines, cross both ribs and grooves.

Left valve nearly flat—sometimes slightly concave, sometimes slightly convex, with radial ribs and scales similar to those of the right valve, but the ribs rather

narrower and the intervening grooves broader. The scale-like projections are sometimes greatly developed.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)
Length .	139	130	130	118	118	113 mm.
Height .	152	135	131	123	122	120 „
(1—6) <i>Perna</i> -bed, Atherfield.						

Affinities.—This species is related to *Hinnites Renevieri* (Coquand),¹ but is distinguished by the ribs being less frequently bifurcated and more nearly straight. *H. Leymerii*, Deshayes,² differs from *H. Favrinus* by the great inequality of the ribs—a few being large with smaller ribs in the interspaces.

Philippi³ has discussed the affinities of the group to which the above-mentioned

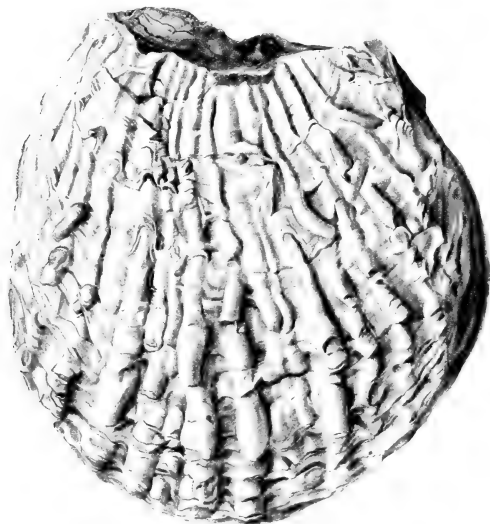


FIG. 7.—*Hinnites Favrinus*, Pict. and Roux. Museum of Practical Geology, No. 8444. Lower Greensand (*Perna*-bed), Atherfield. Left valve. $\times \frac{2}{3}$.

species belong, and is inclined to regard it as genetically independent of the Tertiary species of *Hinnites*. This view seems to be based chiefly on negative evidence, viz. the absence, so far as at present known, of *Hinnites* from the Upper

¹ Pictet and Campiche, 'Foss. Terr. Crét. Ste. Croix' (1870), p. 227, pl. clxxvi.

² Pictet and Campiche, *ibid.*, p. 224, pls. clxxiv, clxxv. Deshayes, 'Mém. Soc. géol. France,' vol. v (1842), p. 27, pl. xiv, fig. 1.

³ 'Zeitschr. d. deutsch. Geol. Gesellsch.,' vol. 1 (1898), p. 601.

Cretaceous and early Tertiary deposits. But until definite evidence of the independent origin of the Tertiary species can be given it seems to me better to refer the Lower Cretaceous species to *Hinnites*, since they agree so closely with the typical species of that genus.

Types.—The specimen referred to *Hinnites Leymerii* by Forbes is in the Museum of the Geological Society (No. 2022). Pictet and Roux's types came from the Aptian of the Perte du Rhône.

Distribution.—*Perna*-bed and Fitton's Bed 13 of Atherfield. Hythe Beds of Court-at-Street, Hythe.

ADDITIONS AND CORRECTIONS.

Page 31. *Placunopsis undulata* (Müller). Two specimens closely resembling this species have been obtained by Mr. R. M. Brydone from the Trimmingham Chalk. Figures are given by Holzapfel (1889) and Ravn (1902).

Page 35. *Barbatia aptiensis* (Pict. and Camp.). This species has been found by the Rev. W. R. Andrews at the base of the Gault at Dinton, in the Vale of Wardour, and recorded as *Arca Raulini* by Mr. Jukes-Browne.

Page 41. *Barbatia Galliennei* (d'Orb.). A specimen has been obtained from the Chloritic Marl of Maiden Bradley.

Page 70. Add *PECTUNCULUS VAUGHANI*, sp. nov. Plate XLII, fig. 11.

Description.—Shell stout, convex, nearly equilateral, but slightly longer anteriorly than posteriorly, with a rounded subquadrate outline; length a little greater than height. Umbones small. Hinge-area very small. Ornamentation consists of numerous flattened radial ribs, separated by linear grooves; the ribs are more numerous on the left valve than on the right, and more numerous on the anterior than on the middle parts of the valves. A few faintly marked growth-lines are seen at intervals. Interior of valves not seen.

Measurements :

Length	.	.	.	.	.	31·5 mm.
Height	.	.	.	.	.	30·0 „

Affinities.—This form presents some resemblance to *P. subconcentricus*, Lamarck,¹ but is more nearly equilateral, has a much smaller hinge-area, and the concentric ridges are absent.

Remarks.—I have seen only one specimen of this species. The two valves are united, and consequently the interior cannot be seen. The specimen was collected by Mr. Arthur Vaughan, B.A., B.Sc., and presented by him to the Woodwardian Museum.

Distribution.—Greensand of Blackdown.

Page 71, line 20 from the top. For “Bed ii” read “Bed 11.”

Page 80. *Trigonia spectabilis*. Reference to Lycett—for pl. xxxvi read pl. xx.

¹ D'Orbigny, 'Pal. Franç. Terr. Crét.', vol. iii (1844), p. 189, pl. cccvi, figs. 12—19.

Page 96. *Modiola ligeriensis* (d'Orb.). The following should be added to the synonymy :—*Modiola striata*, Drouet, 'Mém. Soc. Linn. de Paris,' vol. iii (1824), p. 192, pl. vii, fig. 5. Non *Modiolus striatus* (Mont.), Maton and Rackett, 1807. Non *Modiola striata*, Defrance, 1824.

Page 106. *Septifer lineatus* (Sow.). A specimen from the *Belemnitella mucronata* zone, near Fareham (Hants), has been found by Mr. C. Griffith, of Winchester.

Page 106. "Family Dreissensiidæ, Gray," should be transferred to the middle of Page 110.

Page 111. Line 11 should follow line 5.

Page 112. Footnote 1. For vol. li *read* vol. xliii.

Page 135, line 3. For Kreide *read* Neocoms.

Page 143. For *PLICATULA SIGILLINA read* DIMYODON NILSSONI (*Hagenow*), 1842.

Additional synonymy.

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|-------|---|--|
| 1842. | OSTREA NILSSONI, <i>F. v. Hagenow</i> | Neues Jahrb. für Min., etc., p. 546. |
| 1891. | DIMYODON NILSSONI, <i>J. Böhm.</i> | Die Kreidebildungen des Fürbergs, etc (Palæontographica, vol. xxxviii), p. 89, pl. iv, fig. 7. |
| 1892. | — — <i>E. Stolley.</i> | Die Kreide Schleswig-Holsteins (Mittheil. a. d. Min. Institut. Universit. Kiel, vol. i), p. 242. |
| 1895. | CYCLOSTREON NILSSONI, <i>F. Vogel.</i> | Holländ. Kreide, p. 14, pl. i, figs. 4—7. |
| 1900. | DIMYODON NILSSONI, <i>K. A. Grönwall.</i> | Meddel. Dansk. geol. Foren., No. 6, p. 75. |
| 1902. | — — <i>J. P. J. Ravn.</i> | Mollusk. i Danmarks Kridtfløj. I. Lamellibr. (K. Danske Vidensk. Selsk. Skrift. 6. Række, nat. math. Afd., vol. xi), p. 109. |

After the publication of Part III of this Monograph I received a copy of a paper by K. A. Grönwall on *Dimyodon* in the Danish Chalk. From the figures there given, and also from the one given by Böhm, I think that there can be no doubt as to the identity of *Plicatula sigillina* with the form described (but not figured) by von Hagenow as *Ostrea Nilssoni*. This identity has been confirmed by Mr. J. P. J. Ravn, of Copenhagen, to whom I have sent specimens of *Plicatula sigillina* from Norwich.

Ostrea Nilssoni has been referred by Böhm, Stolley, Grönwall, and Ravn to the genus *Dinnyodon*, Munier-Chalmas.¹ When describing *Plicatula sigillina* I remarked that although it belonged to a type distinct from the other Cretaceous species, yet it resembled the recent form *Plicatula philippinarum*, Hantz. I have not seen the adductor impressions in any specimens of *Plicatula sigillina*, but nevertheless I think that it is quite possible that the authors mentioned may be correct in referring this species to the genus *Dinnyodon*, Munier-Chalmas.

Dinnyodon costatus, Grönwall, seems to be very closely related to *D. Nilssoni*.

Page 152. *Pecten Nilssoni*, Goldf., Plate XLII, figs. 9, 10. Through the kindness of Mr. J. P. J. Ravn I have received specimens of *P. Nilssoni* from the Chalk of Faxe, and I am now able to state that I consider that the specimens from Trimmingham, mentioned on page 152, and also another from the *Act. quadratus* zone of Hampshire (coll. R. M. Brydone), are referable to that species.

¹ In Fischer's 'Manuel de Conchyliol.' (1886), p. 957.

INDEX.

Synonyms are printed in *italics*. The Roman numerals refer to the plates on which the species are figured.

	PAGE		PAGE
Acila	19	<i>Arca tigrisiensis</i>	47
Æquipecten	186—197	— <i>Mailleana</i>	63
Anomia	27—31	— <i>marullensis</i>	38
— convexa	29, v, 10	— <i>nana</i>	62
— lavigata	29, v, 6—9	— <i>obesa</i>	61
— papyracea	31, v, 13—16	— <i>Passyana</i>	47
— — var. <i>burwellensis</i>	31	— <i>pholadiformis</i>	35
— pseudoradiata	27, 30, v, 1—3	— <i>radiata</i>	42
— radiata	27	— <i>Raulini</i>	35
— ? transversa	30, v, 12	— <i>Robinaldina</i>	52
Arca	32—35	— <i>rotundata</i>	40
— <i>aptiensis</i>	36	— <i>rotundita</i>	40
— <i>Austeni</i>	37	— <i>Sanctæ-Crucis</i>	34, vi, 6, 7
— <i>cariata</i>	45	— <i>securis</i>	44
— <i>Carteroni</i>	33, vi, 4, 5	— <i>subformosa</i>	56
— <i>Cornucliana</i>	50	— <i>vendinensis</i>	41
— <i>cynodoce</i>	35		
— <i>Dupiniana</i>	32, vi, 1—3		
— <i>exaltata</i>	49	Barbatia	35—37
— <i>fibrosa</i>	57	— <i>aptiensis</i>	35, 224, vi, 8, 9
— <i>Fittoni</i>	52	— <i>Austeni</i>	37, vii, 1—3
— <i>Forbesi</i>	49	— <i>Gallieniei</i>	41, 224, vii, 9
— <i>formosa</i>	56	— <i>Geinitzi</i>	42, vii, 10, 11
— <i>Gabrielis</i>	49	— <i>Hugardiana</i>	40
— <i>Gallieniei</i>	41	— <i>marullensis</i>	38, vii, 4—7
— <i>Geinitzi</i>	42	— <i>rotundata</i>	40, vii, 8
— <i>glabra</i>	57	— <i>vendinensis</i>	41
— <i>Guerangeri</i>	64	Brachydontes	101—103
— <i>Hugardiana</i>	40	— <i>Guerangeri</i>	101, xvii, 4, 5
— <i>isocardiaformis</i>	65	<i>Byssosarca marullensis</i>	38

	PAGE		PAGE
Camptonectes	152—163	Grammatodon carinatus ...	45, viii, 3—8
<i>Cardium</i> (<i>Hemicardium</i> ?) <i>Austeni</i> ...	37	— <i>securis</i> ...	44, vii, 14—15; viii, 1, 2
— <i>umbonatum</i>	69		
<i>Ceromya crassicornis</i>	65	Hinnites	220—223
<i>Chlamys</i>	163—186	— <i>Favrinus</i>	220, Text-figs 6, 7
— <i>ternata</i>	190	— <i>Leymerii</i>	220
<i>Crenella</i>	104	— <i>pectinatus</i>	220
— <i>bella</i>	104, xvii, 12, 13	— <i>Salteri</i>	218
<i>Cucullæa</i>	49—64	— <i>Studeri</i>	218
— <i>carinata</i>	47, 57	— <i>trilinearis</i>	219
— <i>Cornueliana</i> 50, viii, 11—13; x, 1—3			
— (<i>Idonearca</i>) <i>Cornueliana</i>	51	<i>Idonearca fibrosa</i>	57
— <i>costellata</i>	45	— <i>glabra</i>	57
— (<i>Dicranodonta</i>) <i>donningtonensis</i>		<i>Inoceramus siliqua</i>	99
54, x, 11—14; xi, 1, 2		<i>Isoarca</i>	65, 66
— <i>errans</i>	52	— <i>Agassizi</i>	65, xiii, 7
— <i>fibrosa</i>	57	— <i>cantabrigiensis</i>	65
— <i>Fittoni</i>	52, x, 4—7	— <i>obesa</i>	65, xiii, 8
— <i>Forbesi</i>	49, ix	<i>Isocardia crassicornis</i>	65
— <i>formosa</i>	56	— <i>Orbignyana</i>	65
— <i>Gabrielis</i>	49		
— <i>glabra</i> ... 57, xi, 8—12; xii, 1—5		<i>Janira æquicostata</i>	208, 209
— <i>Mailleana</i>	63, xiii, 4, 5	— <i>atava</i>	197, 198
— <i>nana</i>	62, xiii, 1—3	— <i>cometa</i>	200
— <i>obesa</i>	61, xii, 6—8	— <i>Dutemplei</i>	207, 215, 217
— (<i>Dicranodonta</i> ?) <i>obliqua</i> ...	55, xi, 3, 4	— <i>Faucignyana</i>	210
— <i>Passyana</i>	47	— <i>Fontanieri</i>	203
— <i>securis</i>	44	— <i>Geinitzii</i>	210
— <i>striatella</i>	45	— <i>Morrisi</i>	201
— <i>subnana</i>	50	— <i>neocomiensis</i>	197, 198, 199
— <i>vagans</i>	52, x, 8—10	— <i>quadrivcostata</i>	211, 212
— <i>venusta</i>	56, xi, 5—7	— <i>quinquecostata</i>	201—203, 205
<i>Cyclostreon Nilssoni</i>	225		
<i>Cypricardia undulata</i>	100	<i>Leda angulata</i>	8
		— <i>lineata</i>	7
<i>Dianchora lata</i>	121	— <i>Murice</i>	6
— <i>obliqua</i>	121	— <i>phaseolina</i>	9
— <i>spinosa</i>	125	— <i>scapha</i>	3, 7
— <i>strinta</i>	119	— <i>Seeleyi</i>	5
<i>Dicranodonta</i>	53	— <i>siliqua</i>	11
<i>Dimyodon Nilssoni</i>	225	— <i>solea</i>	5
<i>Dreissensia</i>	110	— <i>spathulata</i>	1, 4
— <i>lanceolata</i>		— <i>subrecurva</i>	2, 9
110, xviii, 13—15; xix, 1—11		— <i>Vibraycana</i>	10
		<i>Lima brightoniensis</i>	128
<i>Grammatodon</i>	44—47	— <i>spinosa</i>	128
		<i>Limopsis</i>	71—73

	PAGE		PAGE
<i>Limopsis albiensis</i>	71, xv, 1, 2—4	<i>Mytilus falcatus</i>	110
<i>Lithodomus</i>	105	— <i>flagelliferus</i>	99
— <i>rugosus</i> ?	105, xvii, 14	— <i>Gallienaei</i>	111
<i>Lucina orbicularis</i>	71	— <i>Guerangeri</i>	101
<i>Lyriodon crenulatus</i>	83	— <i>gurgitis</i>	97
— <i>excentricus</i>	76	— <i>hainoensis</i>	91
— <i>sinuatus</i>	76, 77	— <i>inaequivalvis</i>	91, xv, 7
<i>Lyrodon excentricum</i>	76	— <i>lanceolatus</i>	110
<i>Modiola</i>	92—104	— <i>ligeriensis</i>	96
— <i>æqualis</i>	92, xv, 8—14	— <i>lineatus</i>	106
— <i>angusta</i>	106	— <i>Orbignyanus</i>	107
— <i>bella</i>	104	— <i>peregrinus</i>	107
— <i>Cornueliana</i>	104	— <i>prælongus</i>	110
— <i>Cottæ</i>	106	— <i>reversus</i>	94
— <i>flagellifera</i>	99, xvii, 1, 2	— <i>rugosus</i>	97
— <i>granulosa</i>	106	— <i>semiradiatus</i>	94
(<i>Brachydontes</i>) <i>Guerangeri</i> , 101, xvii, 4, 5		— <i>simplex</i>	97, 114
— <i>levigata</i>	94	— <i>spatulatus</i>	107
— <i>ligeriensis</i>	96, 225, xvi, 4—6	— <i>striato-costatus</i>	103
— <i>lineata</i>	106	— <i>subangustus</i>	106
— <i>obesa</i>	93	— <i>subfalcatus</i>	110
— <i>pedernalis</i>	104	— <i>sublineatus</i>	106
— <i>quadrata</i>	107	— <i>subrugosus</i>	97
— <i>reversa</i>	94, xv, 15—18; xvi, 1—3	— <i>subsimplex</i>	97
— <i>rugosa</i>	97	— <i>tornacensis</i>	91
— <i>simplex</i>	97	— <i>tridens</i>	110
— <i>striata</i>	225	— <i>undulatus</i>	101
(<i>Brachydontes</i>) <i>striato-costata</i> , 103, xvii, 9—11		<i>Neithea</i> (see <i>Pecten</i>)	197—218
— <i>subfalcata</i>	111	<i>Nucula</i>	12—27
— <i>subsimplex</i>	97, xvi, 7—10	— <i>æquilateralis</i>	2
— <i>typica</i>	96	— <i>albensis</i>	24, iv, 9—17
— <i>undulata</i>	100, xvii, 3	— <i>antiquata</i>	26, iv, 22—26
(<i>Brachydontes</i>) <i>vectiensis</i> , 102, xvii, 6—8		— <i>apiculata</i>	23
<i>Myoconcha</i>	114	— (<i>Acila</i>) <i>bivirgata</i>	19, iii, 1—12
— <i>cretacea</i>	114, xx, 3	— <i>capsæformis</i>	21
<i>Mytilus</i>	91, 92	— <i>Cornueliana</i>	13
— <i>abruptus</i>	110	— <i>Derancei</i>	21
— <i>æqualis</i>	92	— <i>gaultina</i>	25, iv, 18—21
— <i>asper</i>	106	— <i>impressa</i>	23, iv, 5—8
— <i>bellus</i>	104	— <i>impressa</i>	12
— <i>ciptyanus</i>	107	— <i>Lamplughii</i>	14, ii, 18, 19
— <i>Cornuelianus</i>	104	— <i>lineata</i>	7
— <i>Cottæ</i>	106	— <i>Moricæ</i>	6
— <i>Cuvieri</i>	106	— <i>Meyeri</i>	15, ii, 21
— <i>edentulus</i>	110	— <i>obesa</i>	65
		— <i>obtusa</i>	22, iv, 2 4

	PAGE		PAGE
<i>Nucula obtusa</i> ...	12	<i>Pecten</i> (<i>Æquipecten</i>) <i>asellus</i> ...	119
— <i>ornatissima</i> ...	19	— — asper	186, xxxv, 12; xxxvi, 1—4
— <i>ovata</i> , Mant. ...	21, iii, 16—21; iv, 1	— (<i>Neithea</i>) <i>atavus</i> ...	197, xxxix, 1—5
— <i>ovata</i> , Phil. ...	12	— (<i>Chlamys</i>) <i>Barretti</i> ...	182, 185
— <i>pectinata</i> ...	16, ii, 22—27; iii, 13	— (<i>Æquipecten</i>) <i>Beaveri</i> ...	188, xxxviii
— — <i>var. cretæ</i> ...	18, iii, 14, 15	— (<i>Chlamys</i>) <i>britannicus</i> ...	167, xxxi, 1, 2
— <i>phaseolina</i> ...	9	— — <i>Brongniarti</i> ...	169
— <i>planata</i> ...	12, ii, 11—15	— (<i>Æquipecten</i>) <i>campaniensis</i>	192, xxxvii, 4—8
— <i>rhomboides</i> ...	10	— (<i>Camptonectes</i>) <i>cinctus</i> ...	152, xxviii
— <i>rhodomagensis</i> ...	65	— (<i>Syncyclonema</i>) <i>circularis</i> , Gein. ...	146
— <i>scapha</i> ...	3	— (<i>Camptonectes</i>) <i>circularis</i> ...	154, 156
— <i>siliqua</i> ...	11	— (<i>Chlamys</i>) <i>comans</i> ...	171, 172
— <i>simplex</i> ...	14	— (<i>Neithea</i>) <i>cometa</i> ...	200, xxxix, 6—10
— <i>solea</i> ...	5	— (<i>Chlamys</i>) <i>concentricus</i> ...	179, 180, 181
— <i>spathulata</i> ...	1	— (<i>Camptonectes</i>) <i>Cottaldinus</i> , 156, xxix, 1—3	
— <i>subelliptica</i> ...	10	— (<i>Syncyclonema</i>) <i>Cottaldinus</i> ...	147
— <i>subrecurva</i> ...	2, 9	— (<i>Camptonectes</i>) <i>crassitesta</i> ...	153, 154
— <i>Vibrayeana</i> ...	10	— (<i>Chlamys</i>) <i>cretosus</i> , 174, xxxii, 4—6; xxxiii	
<i>Nuculana</i> ...	1—11	— — <i>cretosus</i> , Goldf. ...	171
— <i>angulata</i> ...	8, i, 33—35	— — <i>var. nitida</i> ...	176
— <i>lineata</i> ...	7, i, 28—32	— — <i>var. Zeisneri</i> ...	176
— <i>Marie</i> ...	6, i, 25—27	— — <i>crispus</i> ...	171, 176
— <i>phaseolina</i> ...	9, ii, 1—3	— (<i>Camptonectes</i>) <i>curvatus</i>	159, xxix, 7; xxxvii, 16
— (?) <i>Yoldia</i> <i>scapha</i> ...	3, i, 8—14	— (<i>Æquipecten</i>) <i>depressus</i> ...	188, 189
— <i>Seeleyi</i> ...	5, i, 15—17	— (<i>Camptonectes</i>) <i>divaricatus</i> ...	160
— <i>siliqua</i> ...	11, ii, 10	— — <i>dubrisiensis</i> ...	162, xxix, 8
— <i>solea</i> ...	5, i, 18—24	— (<i>Æquipecten</i>) <i>Dujardini</i> ...	190, 191
— <i>spathulata</i> ...	1, i, 1—3	— (<i>Chlamys</i>) <i>Dutemplei</i> ...	182
— <i>speetonensis</i> ...	3, i, 6, 7	— — <i>elongatus</i>	170, xxxi, 10—13; xxxii, 1—3
— <i>subrecurva</i> ...	2, i, 4, 5	— <i>Faujasi</i> ...	171, 173
— <i>Vibrayeana</i> ...	10, ii, 4—9	— — <i>fissicosta</i> ...	163, xxx, 3—8
<i>Ostrea muricata</i> ...	186	— — <i>Galliennei</i> ...	182, 184
— <i>Nilssoni</i> ...	225	— (<i>Camptonectes</i> ?) <i>gaultinus</i> ...	163, xxx, 1, 2
<i>Pachylus spinosus</i> ...	127	— (<i>Syncyclonema</i>) <i>germanicus</i> ...	147, 148
— <i>striatus</i> ...	127	— (<i>Chlamys</i>) <i>hispidus</i> ...	183 (foot-note)
<i>Pecten</i> ...	145—218	— (<i>Camptonectes</i>) <i>imperialis</i> ...	153
(<i>Neithea</i>) <i>æquicostatus</i> ...	208, xl, 8, 9	— (<i>Chlamys</i>) <i>interstriatus</i> ...	181, 182
— <i>æquicostatus</i> ...	203, 215	— (<i>Æquipecten</i>) <i>jugosus</i> ...	189, 190
— — <i>var. longicollis</i> ...	208	— (<i>Syncyclonema</i>) <i>laminosus</i> ...	145, 146, 149
(<i>Chlamys</i>) <i>aptiensis</i> ...	181, 182	— (<i>Camptonectes</i>) <i>leus</i> , <i>var. Morini</i> ...	158
— <i>arachnoides</i> ...	174, 177, 178	— (<i>Æquipecten</i>) <i>lineatus</i> ...	194, 195
(<i>Camptonectes</i>) <i>arcuatus</i> ...	159, 160, 161	— (<i>Chlamys</i>) <i>Mantelli</i> ...	180
(<i>Chlamys</i>) <i>arcuatus</i> ...	175	— <i>Mantellianus</i> ...	179, xxxiv, 1—6
(<i>Æquipecten</i>) <i>arlesiensis</i> , 194, xxxvii, 9—11			
(<i>Camptonectes</i>) <i>arziensis</i> ...	158		

	PAGE		PAGE
<i>Pecten (Chlamys) Marrotianus</i> ...	171, 173	<i>Pecten (Neitheia) versicostatus</i> ...	201, 202, 206, 210
— <i>Milleri</i> ...	168, xxxi, 3—6	(<i>Camptonectes</i>) <i>virgatus</i> ...	160
(<i>Camptonectes</i>) <i>Morini</i> ...	159	(<i>Chlamys</i>) <i>Zeisneri</i> ...	175
(<i>Neitheia</i>) <i>Morrisi</i> ...	201, xxxix, 11—13	<i>Pectinites aculeatus</i> ...	127
— <i>Morrisi</i> ...	204, 206	— <i>asper</i> ...	186
<i>Nilssoni</i> ...	149, 152, 226, xlii, 9, 10	<i>Pectunculus</i> ...	66—70, 224
(<i>Chlamys</i>) <i>nitidus</i> ...	174, 178	<i>euglyphus</i> ...	71, xiv, 13
— <i>obliquus</i> ...	170, 171, 181	<i>marullensis</i> ...	66, xiii, 9, 10
(<i>Syncyclonema</i>) <i>opercularis</i> ...	146	<i>obliquus</i> ...	55
— <i>orbicularis</i> ...	145, xxvii	<i>sublaevis</i> ...	67, xiv, 1—7
— — var. <i>Loh-</i>		<i>umbonatus</i> ...	69, xiv, 8—12
<i>manni</i> ...	147	<i>Vaughani</i> ...	224, xlii, 11
(<i>Syncyclonema</i>) <i>orbicularis</i> , var.		<i>Perissonota</i> ...	11
<i>magnus</i> ...	147, 148	<i>Pinnites unguatus</i> ...	106
(<i>Neitheia</i>) <i>ornithopus</i> ...	197, 199	<i>Placunopsis undulata</i> ...	224
(<i>Chlamys</i>) <i>Passyi</i> ...	182, 184	<i>Plagiostoma brightoniensis</i> ...	127, 131
(<i>Æquipecten</i>) <i>pexatus</i> ...	190, xxxvi, 5—7	<i>spinosa</i> ...	127
— <i>pulchellus</i> ...	194, xxxvii, 12—15	<i>spinosum</i> ...	127
(<i>Chlamys</i>) <i>Puzosianus</i> ...	165, xxx, 9—12	<i>sulcata</i> ...	127
(<i>Neitheia</i>) <i>quadricostatus</i> ...	210, xl, 6, 7	<i>Plicatula</i> ...	134—144
— <i>quinquecostatus</i> ...	202, xxxix, 14—17; xl, 1—5	<i>æquicostata</i> ...	136
— <i>quinquecostatus</i> ...	201, 214	<i>Barroisi</i> ...	141, xxvi, 12—18
(<i>Chlamys</i>) <i>Raulinianus</i> ...	171, 173	<i>Carteroniana</i> ...	135, xxv, 5—12
— <i>Robinaldinus</i> ...	181, xxxiv, 7—12; xxxv, 1—10	<i>gurgitis</i> ...	137, xxv, 13—21
(<i>Camptonectes</i>) <i>Rœmeri</i> ...	153	<i>inflata</i> ...	139, xxvi, 1—11
(<i>Æquipecten</i>) <i>sarumensis</i> ...	192, xxxvii, 1—3	<i>minuta</i> ...	138, xxv, 22—25
(<i>Neitheia</i>) <i>sexcostatus</i> ...	214, xl, 10—15; xli, 1—10	<i>nodosa</i> ...	141
(<i>Æquipecten</i>) <i>spurius</i> ...	194, 195	<i>pectinoides</i> ...	137, 141
— <i>Staszyci</i> ...	195	<i>placynata</i> ...	134
(<i>Neitheia</i>) <i>striato-costatus</i> ? ...	217, xli, 9, 10	<i>placunea</i> ...	134, xxv, 1—4
(<i>Camptonectes</i>) <i>striato-punctatus</i> ...	157, xxix, 4—6	<i>radiola</i> ...	137, 139
— <i>striato-punctatus</i> ...	160	<i>sigillina</i> ...	143, 225, xxvi, 19—22
(<i>Chlamys</i>) <i>Stutchburianus</i> ...	185, xxxv, 11	<i>spinosa</i> ...	139
— <i>Stutchburienis</i> ...	185	<i>Podopsis striata</i> ...	120
— <i>subacutus</i> ...	169, xxxi, 7—9	<i>Portlandia pectinata</i> ...	16
— <i>subinterstriatus</i> ...	175, 182, 184	<i>Scaphula</i> ...	37
(<i>Syncyclonema</i>) <i>sublaminosus</i> ...	146, 149	<i>lineatus</i> ...	106, 225, xviii, 1—12
(<i>Æquipecten</i>) <i>subpulchellus</i> ...	195	<i>Spondylus</i> ...	116—134
— <i>ternatus</i> ...	191	<i>æqualis</i> ...	128
(<i>Neitheia</i>) <i>triplicata</i> ...	214	<i>æquicostatus</i> ...	122, 123
(<i>Chlamys</i>) <i>undulatus</i> ...	175	<i>Brunneri</i> ...	117
		<i>capillatus</i> ...	119
		<i>dichotomus</i> ...	143
		<i>duplicatus</i> ...	128, 131

	PAGE		PAGE
Spondylus Dutempleanus		<i>Trigonia excentrica</i> ...	76, 77
125, xxii, 11—14; xxiii, 1—5		— Fittoni ...	88
<i>Dutemplei</i> ...	125	— <i>hunstantonensis</i> ...	73
gibbosus ...	117, xx, 5—11	— ingens ...	75
latus ...	121, xxii, 1—10	— <i>Keepingi</i> ...	75
<i>latus</i> , Desh. ...	116	— <i>leviuscula</i> ...	77
<i>lineatus</i> ...	121	— Meyeri ...	84
<i>obliquus</i> ...	121	— nodosa ...	78
<i>padopsideus</i> ...	127	— ornata ...	85, xix, 13
<i>radiatus</i> ...	116	— pennata ...	88
Rœmeri ...	116, xx, 4	— <i>pseudospinosa</i> ...	87
serratus ...	124, xxi, 6, 7	— Robinaldina? ...	74
spinatus ...	127, xxiii, 6—11; xxiv, 1—7	— <i>rudis</i> ...	78
striatus ...	119, xxi, 1—5	— scabricola ...	82
<i>strigilis</i> ...	134	— scapha ...	73, xx, 1, 2
<i>subspinatus</i> ...	128	— <i>sinuata</i> ...	76, 77
<i>superbus</i> ...	128, 132	— spectabilis ...	80, 224
Synecyclonema ...	145—152	— spinosa ...	86
orbicularis ...	147	— <i>spinosa</i> ...	87
<i>sublaminosa</i> ...	147	— sulcataria ...	89
		tealbyensis ...	79
Trigonia ...	73—90	— upwarensis ...	86
affinis ...	77	— Vectiana ...	84
<i>alveformis</i> ...	83, 84	— Vicaryana ...	87
aliformis ...	83	Trigonoarca ...	47, 48
Archiaciana ...	86	Passyana ...	47, viii, 9, 10
carinata ...	90		
caudata ...	81	Velopecten ...	218—220
<i>cineta</i> ...	78	pectinatus ...	220, xlii, 6
<i>clavellata</i> ...	78	Studerii ...	218, xli, 11; xlii, 1—4
costigera ...	88	trilinearis ...	219, xlii, 5
crenulata ...	82, xix, 14	<i>Vola æquicostata</i> ...	208
crenulifera ...	82	<i>atava</i> ...	198
Cunningtoni ...	90	<i>Dutemplei</i> ...	215
dædalea ...	80	<i>Morrisi</i> ...	202
<i>dædalea</i> ...	79	<i>quadrucostata</i> ...	211, 212
debilis ...	78	<i>quingucostata</i> ...	203, 204, 205
dunscombensis ...	78, xix, 12		
eccentrica ...	76, 77	Yoldia ...	3
Etheridgei ...	81	scapha ...	4
exaltata ...	74		



PLATE XXXIX.

PECTEN (*continued*).

FIGS.

- 1—5. *P. (Neithea) atarus*, Röm. Lower Greensand, Upware. 1, 5, Mr. J. F. Walker's Collection. 2, 3, 4, Woodwardian Museum. (P. 197.)

1, right valve. 2, left valve. 3 *a*, right valve; 3 *b*, posterior view of both valves.
4 *a*, right valve; 4 *b*, portion between the two middle ribs of left valve $\times 3$;
4 *c*, portion between the two middle ribs of right valve $\times 3$. 5, portion
between the two middle ribs of right valve $\times 4$.

- 6—10. *P. (Neithea) cometa* (d'Orb.). Upper Greensand, Warminster. (P. 200.)

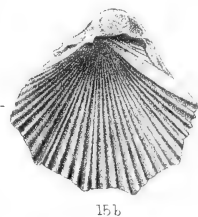
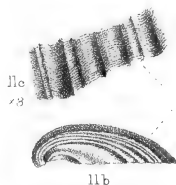
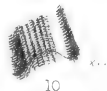
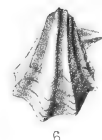
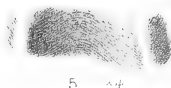
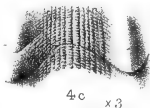
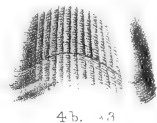
6. British Museum, No. 38267. Right valve.
7. Woodwardian Museum. *a*, right valve; *b*, posterior view of the same; *c*, anterior
view of same.
8. British Museum, No. 88871. Left valve.
9. Museum of Practical Geology, No. 8278. Right valve.
10. Same museum, No. 8445. Portion of right valve $\times 4$.

- 11—13. *P. (Neithea) Morrisi* (Pict. and Renev.). (P. 201.)

11. Hythe Beds, Lympe. Museum of Practical Geology, No. 8364. *a*, right
valve; *b*, posterior view of the same; *c*, portion between two main ribs $\times 3$.
12. Same locality, etc., No. 8446. *a*, left valve; *b*, posterior view of the same.
13. *Perna*-bed, Atherfield. Woodwardian Museum. Left valve—posterior margin
restored.

- 14—17. *P. (Neithea) quinquecostatus*, Sow. (P. 202.)

14. Upper Greensand, Ventnor. York Museum. *a*, right valve; *b*, anterior view
of the same.
15. Upper Greensand (zone of *Pecten asper*), Shaftesbury. Bristol Museum.
a, right valve; *b*, left valve; *c*, anterior view.
16. Same horizon, Warminster. Museum of Practical Geology, No. 8419. *a*, right
valve; *b*, anterior view of the same.
17. Upper Chalk (? *M. cor-anguinum* zone), Gravesend. Museum of Practical
Geology, No. 8362. *a*, right valve; *b*, left valve; *c*, posterior view of the
same specimen.



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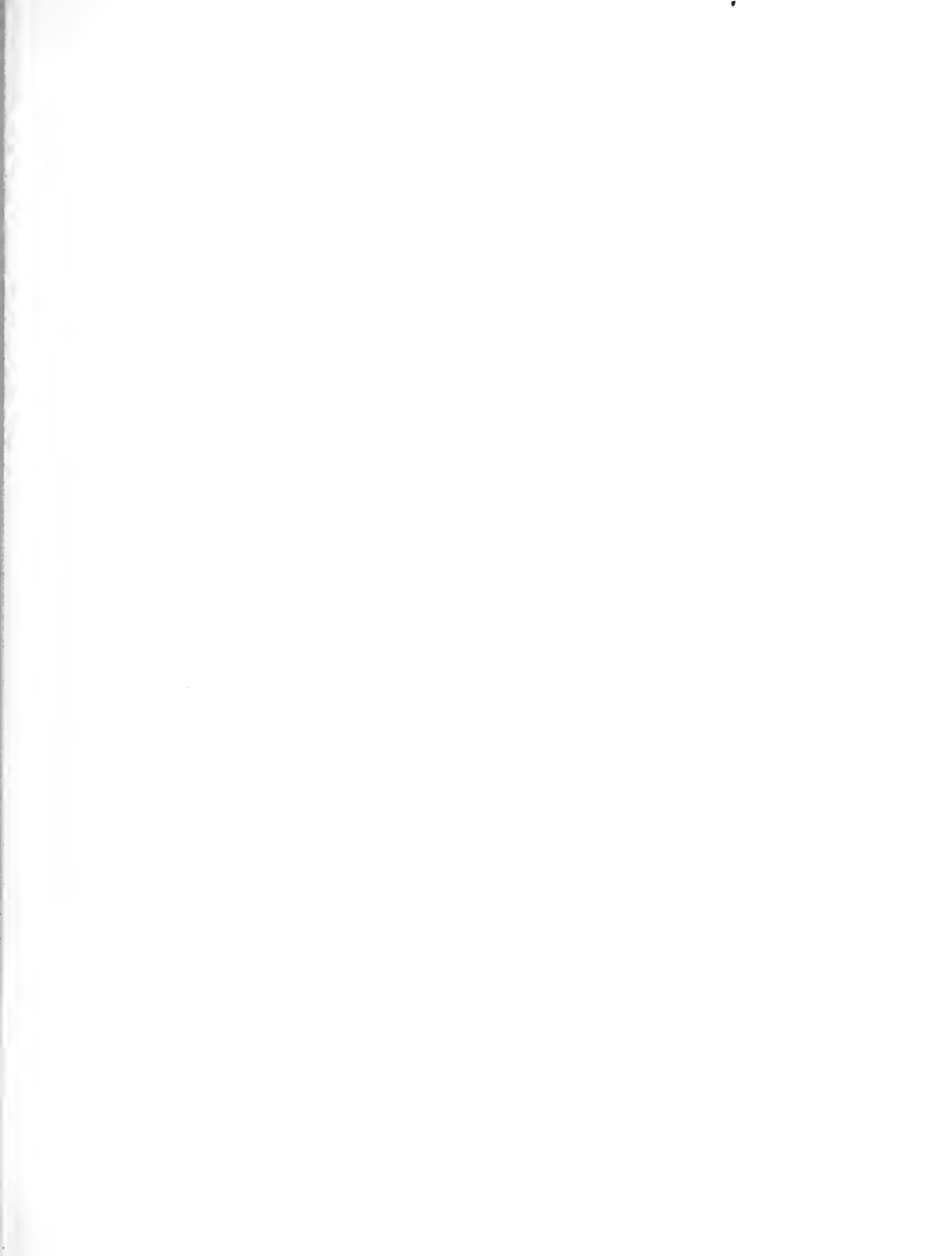


PLATE XL.

PECTEN (*continued*).

FIGS.

1—5. *P. (Neithea) quinquecostatus*, Sow. (P. 202.)

1. Cenomanian (Meÿer's Bed 12), Dunscombe. Woodwardian Museum. Portion between two main ribs of right valve $\times 6$.
2. Upper Chalk (*A. quadratus* zone), West Harnham, Salisbury. Dr. Blackmore's Collection. *a*, right valve; *b*, anterior view; *c*, portion of right valve $\times 4$.
3. Upper Chalk, probably Sussex. British Museum, No. 74979. Right valve.
4. Upper Chalk (? *M. cor-anguinum* zone), Gravesend. Bristol Museum. *a*, right valve; *b*, portion of the same between two main ribs $\times 4$.
5. Upper Chalk, Sussex. British Museum (Dixon Collection), No. L. 14742. Right valve.

6, 7. *P. (Neithea) quadricostatus*, Sow. (P. 210.)

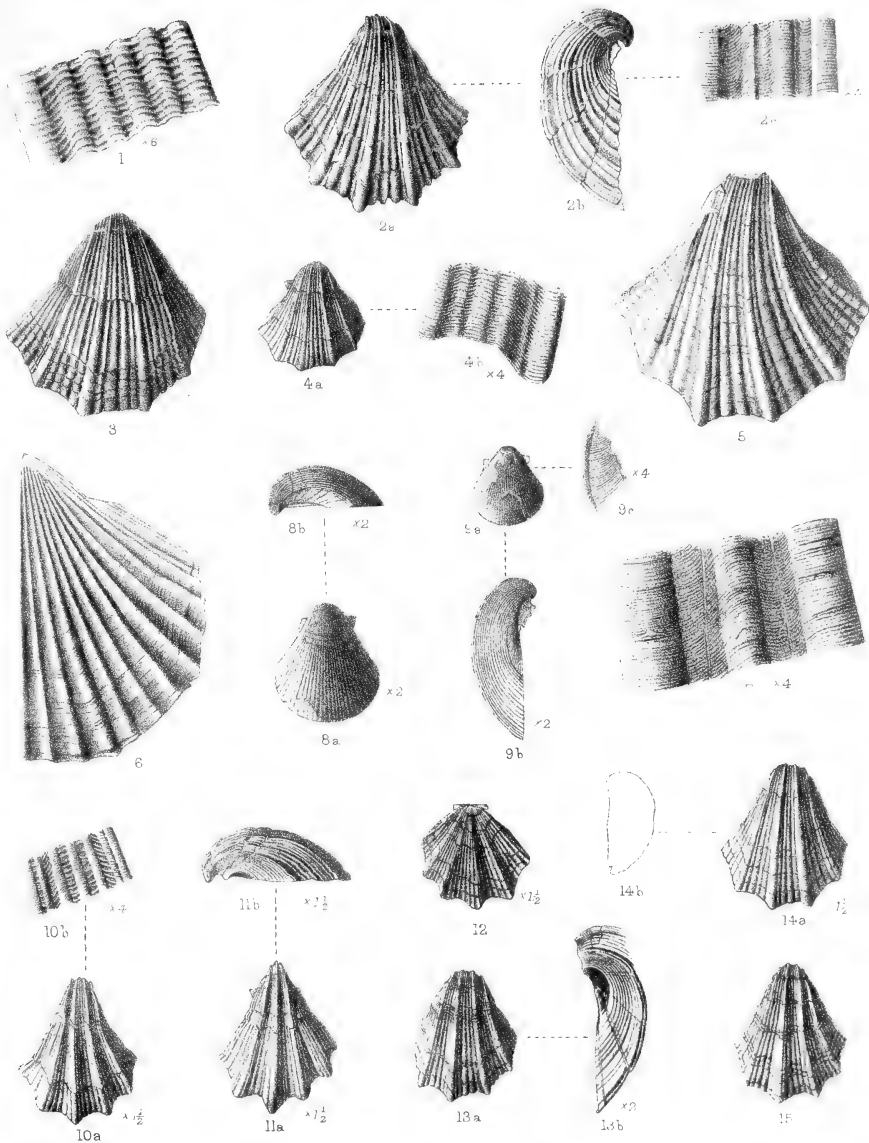
6. Upper Greensand (Chert Beds), Sutton Veny, Warminster. Woodwardian Museum. Posterior half of left valve.
7. Upper Greensand, Warminster. Woodwardian Museum. Portion of right valve $\times 4$. (The line near the middle of each furrow is accidental.)

8, 9. *P. (Neithea) æquicostatus*, Lam. (P. 208.)

8. Upper Greensand, Worbarrow. Museum of the Geological Society, No. 1530. *a*, right valve $\times 2$; *b*, posterior view of the same $\times 2$.
9. Upper Greensand (Chert Beds, zone of *P. asper*), Haldon. Bristol Museum. *a*, right valve; *b*, anterior view of the same $\times 2$; *c*, part of anterior ear of the same $\times 4$.

10—15. *P. (Neithea) sexcostatus*, Woodw. Upper Chalk (*A. quadratus* zone), East Harnham, Salisbury. Dr. Blackmore's Collection. Right valves, except fig. 12. (P. 214.)

- 10 *a*, $\times 1\frac{1}{2}$; 10 *b*, portion of same $\times 4$; 11 *a*, $\times 1\frac{1}{2}$; 11 *b*, posterior view of the same $\times 1\frac{1}{2}$; 12, left valve $\times 1\frac{1}{2}$; 13 *a*, natural size; 13 *b*, part of posterior view of the same $\times 2$; 14 *a*, $\times 1\frac{1}{2}$; 14 *b*, outline of the same, posterior aspect, natural size; 15, natural size.



T. A. Brock del.
A. T. Hollick lith.

West, Newman mut

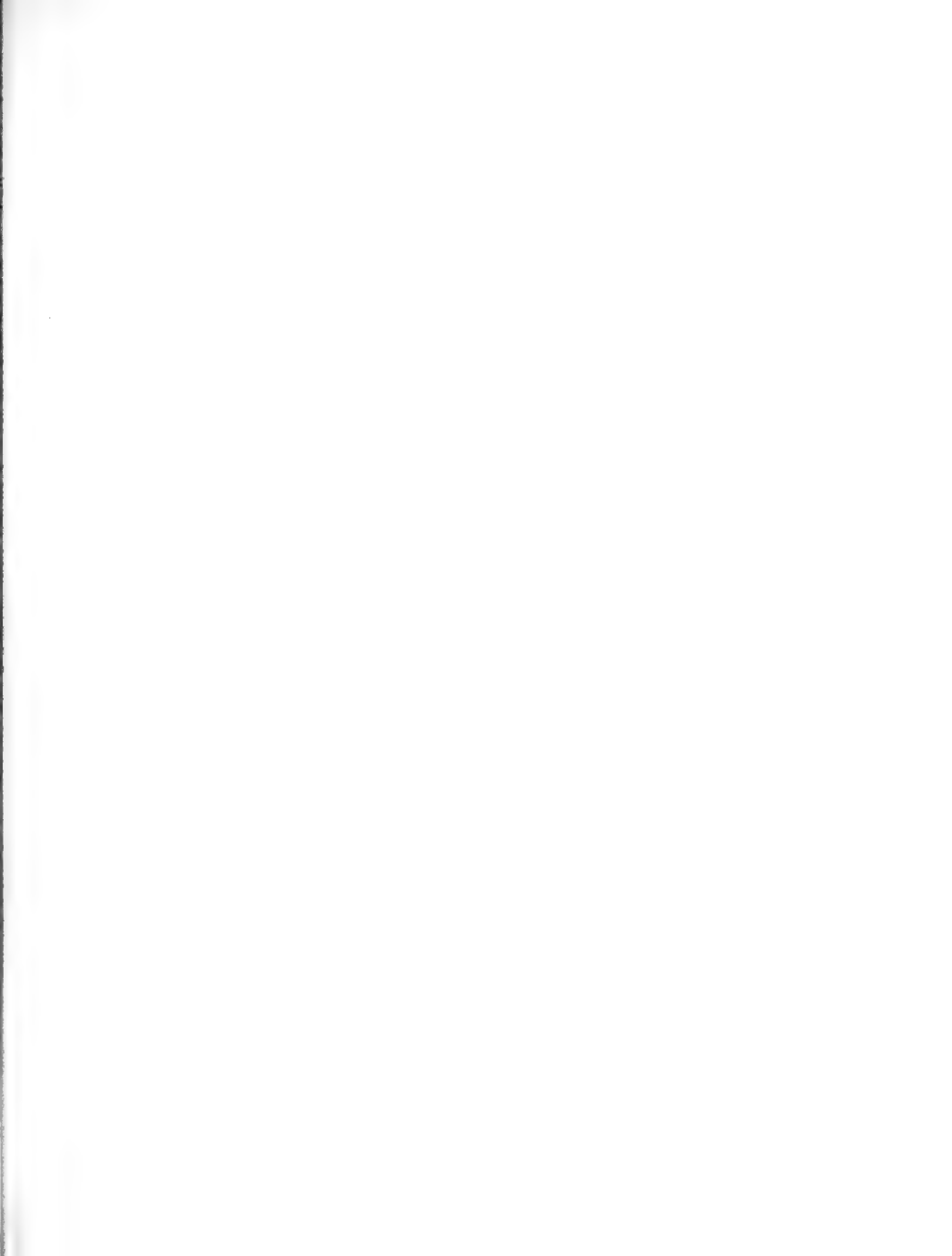


PLATE XLI.

PECTEN (*continued*).

FIGS.

1—8. *P. (Neithea) seecostatus*, Woodw. 1—5, Form β , Upper Chalk. 6—8, Form α , Lower Chalk. (P. 214.)

1. *A. quadratus* zone, East Harnham, Salisbury. Dr. Blackmore's Collection. *a*, right valve; *b*, portion of the two middle main ribs and part between $\times 4$.

2. Same horizon, etc. *a*, right valve; *b*, posterior view of the same.

3. *B. mucronata* zone, Hartford Bridge, Norwich. Woodwardian Museum. *a*, right valve $\times 1\frac{1}{2}$; *b*, portion of the same near the ventral margin $\times 4$; *c*, portion dorsal to middle of valve $\times 4$.

4. *B. mucronata* zone, Norwich. Norwich Museum. Right valve $\times 2$.

5. *A. quadratus* zone, East Harnham. Dr. Blackmore's Collection. Right valve. Portion of the two middle main ribs and part between $\times 4$.

6—8. Chalk Marl, Dover. Woodwardian Museum. Right valves. 6 *a*, $\times 1\frac{1}{2}$; 6 *b*, posterior view of the same $\times 2$; 6 *c*, part between two main ribs $\times 4$. 7 *a*, $\times 1\frac{1}{2}$; 7 *b*, posterior view of the same $\times 1\frac{1}{2}$; 7 *c*, part between two main ribs $\times 4$. 8 *a*, $\times 1\frac{1}{2}$; 8 *b*, part between two main ribs $\times 4$.

9, 10. *P. (Neithea) striatocostatus?* Goldf. Chalk, Trimmingham. Museum of Practical Geology (Coll. Mr. Clement Reid). (P. 217.)

9 *a*, portion of right valve; 9 *b*, part of the same $\times 6$. 10 *a*, left valve $\times 2$; 10 *b*, part of the same $\times 5$.

Genus—VELOPECTEN, *Philippi*.

11. *V. Studeri* (Pict. and Roux). Upper Greensand, Warminster. York Museum. (P. 218.)

11 *a*, left valve; 11 *b*, part of the same $\times 2$; 11 *c*, right valve of the same specimen.

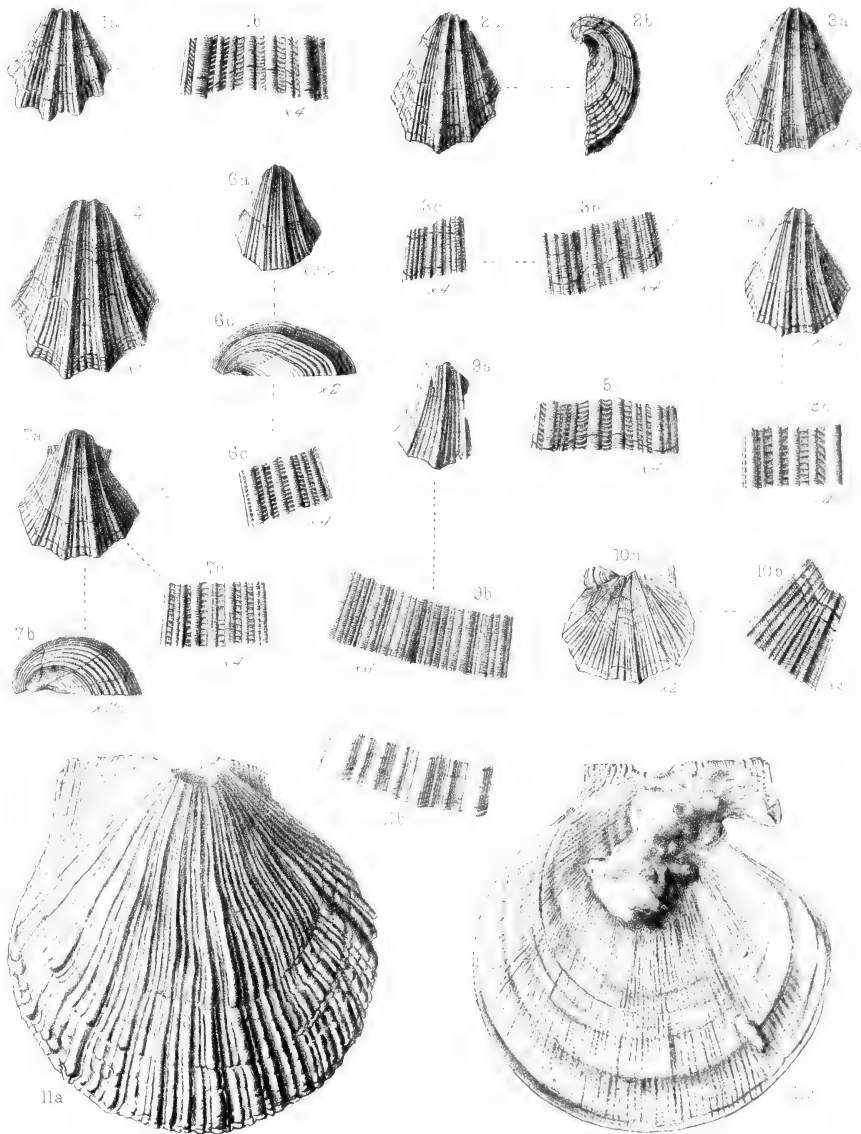




PLATE XLII.

VELOPECTEN (*continued*).

FIGS.

1—4. *V. Studeri* (Pict. and Roux). (P. 218.)

1. Gault, Folkestone. Wiltshire Collection, Woodwardian Museum. Left valve.
2. Gault (Bed xi), Folkestone. Museum of Practical Geology, No. 1612. Left valve.
3. Cambridge Greensand (derived). Internal cast in phosphate. Woodwardian Museum. Imperfect left valve.
4. Red Limestone, Hunstanton. Woodwardian Museum. *a*, antero-ventral portion of left valve of a large specimen; *b*, portion of the same $\times 4$.

5. *V. trilinearis* (Seel.). Cambridge Greensand (derived). Woodwardian Museum. The type. *a*, left valve; *b*, part of the same near the ventral margin $\times 3$. (P. 219.)

6. *V. pectinatus* (Seel.). Cambridge Greensand. Woodwardian Museum. The type. *a*, part of left valve; *b*, portion of the same $\times 3$. (P. 220.)

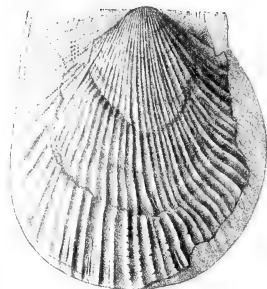
7, 8. *V. sp.* Gault, Folkestone. Wiltshire Collection, Woodwardian Museum. 7, left valve. 8, portion of another left valve $\times 4$. (P. 220.)

9, 10. *Pecten Nilssoni*, Goldf. Upper Chalk. Mr. R. M. Brydone's Collection. (Pp. 152, 226.)

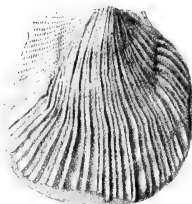
9. Trimingham. Portion of left valve.

10. *A. quadratus* zone, Hampshire. Right valve.

11. *Pectunculus Vaughani*, Woods. Greensand, Blackdown. Woodwardian Museum (Coll. Mr. A. Vaughan). Left valve. (P. 224.)



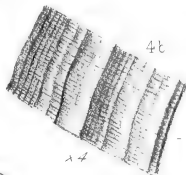
1



2



3

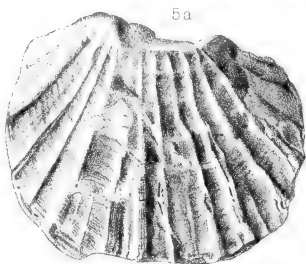


4b

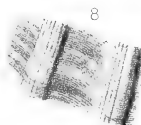
x4



4a

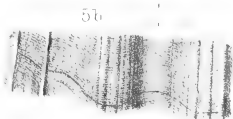


5a



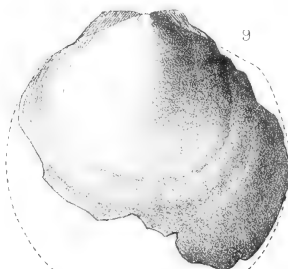
8

x4



5b

x4



9



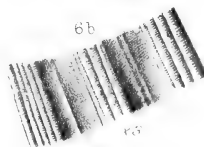
7



6a

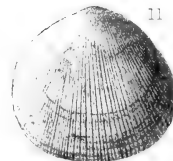


10



6b

x4



11

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A MONOGRAPH
OF THE
BRITISH CARBONIFEROUS
LAMELLIBRANCHIATA.

BY
WHEELTON HIND, M.D., B.S.LOND., F.R.C.S., F.G.S.,
MEMB. SOC. GEOL. BELG.

VOL. II.

PART II.

PAGES 35—124: PLATES VII—XXI.

LONDON:
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1903.

Exterior.—The surface is ornamented with numerous concentric, rounded, low ridges and grooves, not always equidistant.

Dimensions.—Pl. VI, fig. 16, from Castleton, measures—

Antero-posteriorly	.	.	.	.	25 mm.
Dorso-ventrally	.	.	.	.	30 mm.
From side to side	.	.	.	.	12 mm.

Locality.—The Carboniferous Limestone of Castleton, Derbyshire.

Observations.—De Koninck states that *P. obliqua* occurs very rarely in the Carboniferous Limestone of Visé. It is not at all a common shell at Castleton, which is the only locality at which I have yet obtained the species, but several specimens have been found here. The shell is much more gibbose and narrower from side to side than *P. Beecheri*, and the concentric ridges are much closer and narrower. The umbones do not seem to have been contiguous, one of the specimens showing a small area; but no details of the nature of the hinge-plate have been observed.

Family LIMIDÆ.

Genus LIMATULINA, de Koninck, 1886.

LIMATULINA, pars, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 243.

Generic Characters.—Shell small, very inequivalve, generally obliquely swollen, triangularly ovate. The left valve gibbose, its umbo overlapping the right valve, which is flat. Ears depressed, the posterior not being well defined. The anterior ear in the right valve deeply slit for the byssus. The hinge-line straight, and the hinge-plate consisting of a single transverse groove. Exterior surface ornamented by radiating striæ and ribs, which are generally close and numerous, and often rugose.

Observations.—This genus was established by de Koninck for a series of inequivalve, *Pecten*-like shells in which the left valve is much larger than the right valve, and the left umbo arches over and overlaps the small, almost obsolete umbo of the right valve. De Koninck described six species, but I do not think *L. selecta* can belong to this genus. McCoy's *Lima alternata* should certainly, I think, be placed in the genus, while shells with well-defined posterior ears should be excluded.

The genus *Limatulina* is closely related to *Eumicrotis*, but the latter has a smooth shell; though the inequality of the valves and the different characters of the umbones are very similar to the condition in each genus.

LIMATULINA SCOTICA, sp. nov. Plate IX, figs. 1—5.

Specific Characters.—Shell small, quadrately suborbicular, very inequivalve, subauriculate. The right valve only slightly convex, the left triangularly gibbose and compressed at the antero- and postero-superior angles. The anterior and inferior margins rounded, the posterior concavo-convex from above downwards. The hinge-line straight, of medium length, forming well-marked angles at each extremity with the anterior and posterior borders. The umbones almost central, that of the right valve small, not elevated, and inconspicuous, the left raised above the hinge-line, gibbose and incurved. The anterior superior angle marked off in the right valve, but a deep triangular slit reaching almost up to the umbo, for the passage of the byssus, but marked off in the left valve by a more or less well-defined groove. The posterior superior angle of both valves compressed and subauriculate.

Interior.—Below the umbo, in the left valve is a transverse groove which received the cartilage; that in the right valve is not so deep.

Exterior.—The surface is ornamented with many simple fine radiating ribs and sulci, whose regularity is at times interfered with by obscure lines of growth, which are most marked towards the posterior superior angle.

Dimensions.—Pl. IX, fig. 2, from Muirfoot Burn, New Cumnock, measures—

Antero-posteriorly	.	.	.	.	21 mm.
Dorso-ventrally	.	.	.	.	20 mm.
From side to side	.	.	.	.	9 mm.

Locality.—Upper Limestone series, Muirfoot Burn, New Cumnock, Ayrshire.

Observations.—I have collected specimens of this species with Mr. J. Smith at Muirfoot Burn, New Cumnock, where it is accompanied by *Lingula mytiloides*, *Nucula gibbosa*, *Nuculana levistriata*, *N. attenuata*, and *Cardiomorpha limosa*. None of the specimens are quite perfect, but I have fortunately been able to obtain for study and illustration bivalved examples, which show the characteristic features of the genus. In these specimens the left valve very frequently has both ears missing, and this imperfection gives quite a false idea of the antero-posterior diameter of the valve at the hinge-line. The left umbo is very large, and quite overlaps the diminutive one of the right valve. The hinge-line is elongate and hollow, apparently not striated, and receives a cartilage which united the valves.

Singly, the valves might be mistaken for those small species of *Aviculopecten* with fine radiating striæ.

LIMATULINA ALTERNATA, *McCoy*, sp., 1844. Plate XIX, figs. 7—10, 12.

LIMA ALTERNATA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 87, pl. xv, fig. 4.

— PRISCA, *McCoy*, 1844. Ibid., p. 88, pl. xviii, fig. 6.

Specific Characters.—Shell small, narrow, produced downwards, very gibbose, right valve less so than the left, slightly oblique. The anterior border long, gently convex, the lower margin more round, and the posterior elongate and almost straight. The hinge-line short and straight. The umbones small, pointed, central, that of the left valve overlapping the right valve. Ears not defined. The anterior ear of the left valve rolled, the posterior gently and gradually compressed. An elongate area along the hinge-line.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous fine, somewhat sinuous, fibrillose, radiating ribs, often alternately large and small. The ribs are often moniliform, being broken up below into rows of irregularly sized tubercles. Both valves have a similar ornament. Concentric lines and rugæ of growth, irregular in strength, cross the ribs at various intervals.

Dimensions.—Pl. XIX, fig. 8, a specimen from Narrowdale, measures—

Antero-posteriorly 29 mm.

Dorso-ventrally 24 mm.

Localities.—England: the Carboniferous Limestone of Hill Bolton, Yorkshire; Narrowdale, Staffordshire; Park Hill, Derbyshire; Poolvash, Isle of Man. Ireland: Blackrock and Little Island, and Streamhill, co. Cork; Ardagh, co. Meath.

Observations.—I have examined the types of *McCoy*'s species *Lima alternata* and *L. prisca*, and have come to the conclusion that the latter is only the young and therefore less expanded form of the former. Whether or no the valve shows alternating ribs, depends entirely on age. I have been fortunate enough to obtain specimens of both valves, and the right is certainly flatter than the left valve. *L. alternata* is easily distinguished from all other species of the genus by its peculiar and highly ornamental markings. The shell seems to have been very thin in full-grown examples, as it is often found expanded and buckled.

Streblopteria ellipsoidea and *Limatulina linguata*, de Koninck, have an appearance and contour very similar to *McCoy*'s shell.

LIMATULINA DESQUAMATA, *McCoy*, sp., 1844. Plate XIX, figs. 11, 20—23.

PTERINEA DESQUAMATA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 82, pl. xiii, fig. 2.

PECTEN CONOIDEUS, *McCoy*, 1844. Ibid., p. 91, pl. xvii, fig. 2.

Specific Characters.—Shell small, equivalve, gibbose, and triangularly ovate, its antero-posterior diameter much less than the dorso-ventral diameter. The anterior and posterior margins oblique and almost straight, the inferior margin rounded. The hinge-line straight, of moderate length. The umbones pointed, narrow, incurved and raised, gibbose, almost central. The anterior ears depressed, well defined, and triangular, the margin falcate; the posterior ear flattened and depressed, of moderate size, the margin falcate.

Interior.—Hinge appears to be without teeth. Adductor muscle-scar normal in position. Surface smooth in the umbonal region, striated below.

Exterior.—The surface of both valves is ornamented with numerous narrow, somewhat irregular sharp radiating ridges, fresh ribs becoming intercalated between the primary ones as they pass from the umbo to the circumference. Some few irregular concentric rugae of growth. The anterior ears are crossed by numerous fine radiating ribs, the posterior ears by about seven radiating ribs, the lower ones being wider apart than the upper ones.

Dimensions.—Pl. XIX, fig. 23, measures—

Antero-posteriorly	.	.	.	.	27 mm.
Dorso-ventrally	.	.	.	.	29 mm.

Localities.—England: the Carboniferous Limestone of Settle and Hill Bolton, Yorkshire; Redesdale Ironstone, Northumberland. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Town plots, Killala, co. Mayo.

Observations.—*L. desquamata* is on the whole a broader and less gibbose shell than *L. alternata*, while its ribs are more regular in their passage across the shell and better defined. The ears are also better defined and depressed, and more regularly ribbed.

This species was referred by McCoy to *Pterinea* with another shell, which evidently belongs to a different genus and species, *Pterinea intermedia*, because it has a very elongate hinge, with a markedly elongate posterior ear. McCoy's description of *L. desquamata* is very good, and the peculiar characters of the shell are easily recognised in it. I was unable to find the type specimen in the Griffith Collection at the Royal College of Science, Dublin.

Genus PALEOLIMA, nov.

LIMATULINA, pars, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 246.

Generic Characters.—Shell below medium size, obliquely ovate, almost equivalve, moderately swollen. Umbones small, pointed, almost central; ears small, depressed, apparently not slit for the byssus. Exterior surface smooth, or with well-marked

radiating ribs and sulci. A deep groove between the umbones in each valve for the cartilage or ligament.

Observations.—This genus has been erected for shells which have somewhat the external form of *Lima*, but evidently differ from this genus in some details. So far as the hinge can be observed there are no hinge-teeth, and a strong ligament, which is external and lodged in a comparatively deep and broad groove, is therefore necessary. Three species are now referred to *Palæolima*.

PALÆOLIMA SIMPLEX, *Phillips*, sp., 1836. *McCoy*, *emend.* 1844. Plate XIX, figs. 24—27.

? PECTEN SIMPLEX, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 27.

AVICULA SIMPLEX, *de Koninck* (pars), 1843. Descr. Anim. Foss. Belg., p. 137, pl. iv, fig. 2.

PECTEN SIMPLEX, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 100.

? AVICULOPECTEN DUPLICIRADIATUS, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 239, pl. xxxiv, fig. 1.

cf. LIMATULINA RADULA, *de Koninck*, 1885. Ibid., p. 246, pl. xxxvi, fig. 15.

Specific Characters.—Shell small, almost equivalve, oblique, triangularly ovate, gibbose. The anterior border nearly straight, the lower margin curved, the posterior oblique and almost straight. The hinge-line very short, the umbones gibbose, pointed, incurved, slightly raised, and almost central. The ears small and depressed, not well defined, the posterior very small. A few obscure concentric lines of growth.

Interior.—Unknown.

Exterior.—The surface is ornamented with several broad, bifurcating, unequal, radiating ribs, the anterior ribs flattened, the posterior ribs angular. Ears smooth.

Dimensions.—Pl. XIX, fig. 24, a right valve from Poolvash, measures—

Antero-posteriorly	.	.	.	.	20 mm.
Dorso-ventrally	.	.	.	.	20 mm.

Localities.—England: the Carboniferous Limestone of Settle; above Hardraw Scar Limestone, Millgill Asgrigg, Yorkshire. Isle of Man: Carboniferous Limestone, Poolvash. Scotland: the Carboniferous Limestone series, Teasses, Largo; Burn at Craigdouffie, Kilsyth; Glen Hind og Dalry. Ireland: the Carboniferous Limestone, Little Island, co. Cork.

Observations.—The type of *Phillips's Pecten simplex* has disappeared, and the description and figure are very meagre and poor. *McCoy*, however, gave a better description, from which the shell is fairly easily recognised; but he describes the right valve as “nearly flat,” a statement I cannot accept, the right being only a little less gibbose than the left valve.

De Koninck figured two shells of very different appearance in his first work, 1843, and subsequently in 1885 re-described his shell under the name *Ariculopecten ? dupliciradiatus*. The writer of the description of this shell states that de Koninck confounded his species with that of Phillips, but that it differs in possessing bifurcating radiating ribs. Now one of the few characters that Phillips's figure does undoubtedly show, is that of having bifurcating radiating ribs. I have, therefore, no hesitation in placing de Koninck's specific name as a synonym of *P. simplex*. I strongly suspect that *Limatulina radula* belongs to the same species.

Phillips says of his species, "Upper valve, fig. 27, much flatter," but the figure shows a comparatively gibbose shell.

PALEOLIMA LEVIS, sp. nov. Plate XIX, figs. 13 -16.

Specific Characters.—Shell small, slightly inequivalve, gibbose, ovate, oblique, with lower part of the posterior margin produced. The anterior border rounded and short. The posterior margin almost straight and very oblique. Hinge-line straight, of moderate length. Umbones gibbose, pointed, placed almost at the centre of the hinge-line. That of the left valve larger and more elevated than that of the right valve. Ears very marked, narrow, the posterior the longer, while the anterior is deeper.

Interior.—Unknown.

Exterior.—Surface smooth. Ears smooth.

Dimensions.—Pl. XIX, fig. 13, a right valve, measures—

Antero-posteriorly 14 mm.

Dorso-ventrally 13 mm.

Locality.—Ireland: the Carboniferous Limestone of Little Island, co. Cork.

Observations.—I cannot find any previous description of this little shell. In the cabinet of Mr. J. Wright, of Belfast, there is a tablet of seven specimens which have served for the description of the species. Two of them are right valves and the others left valves. The oblique character of the shell and the overlapping of the left umbo have induced me to place the species in the genus *Paleolima*.

PALEOLIMA OBLIQUIRADIATA, sp. nov. Plate XIX, figs. 17—19.

Specific Characters.—Shell of moderate size, transversely oblique, oval, obliquely gibbose, inequivalve, very inequilateral. Ears almost obsolete. The anterior border ellipsoidal, the lower margin slightly convex in front, produced downwards and more convex posteriorly. The posterior border almost straight, very oblique

and truncate. Hinge-line straight and short. Umbones small, oblique, pointed, placed about the junction of the anterior and middle thirds of the hinge-line. The anterior ear small and depressed, not very sharply defined from the rest of the valve. The posterior ear much depressed, narrow, and its posterior superior angle greater than a right angle. The valve obliquely swollen and its greatest convexity nearer the posterior than the anterior border. The dorsal slope well marked and broad, forming a broad oblique hollow groove which lies between the ear and an oblique angular ridge, which forms the posterior margin of the valve.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous broad, flat, radiating ribs, some of which bifurcate as they pass across the shell. The ribs are broader, and the grooves that separate them less deep, in the anterior part of the valve. The ribs are crossed by concentric rugæ and lines of growth. The ears are without radiating ridges and have only lines of growth.

Dimensions.—Pl. XIX, fig. 17, a left valve from Settle, measures—

Antero-posteriorly	46 mm.
Dorso-ventrally	24 mm.
Gibbosity of valve	7.5 mm.

Localities.—The Carboniferous Limestone of Settle, Yorkshire, and Park Hill, Derbyshire.

Observations.—This species differs from *P. simplex* in its great obliquity, and possesses more numerous and flatter ribs than that species. A series of three specimens from Settle, one of which (Pl. XIX, fig. 18) is bivalved, are in the Woodwardian Museum, Cambridge, and I have three specimens in my cabinet from Park Hill, Derbyshire. Unfortunately the hinge-line is not quite perfect in any of them, and the anterior ear is not well exposed. The peculiar characters of the species are so well marked that it is not likely to be confounded with any other. The radiating ribs are not well marked in young examples or in the umbonal region of the full-grown specimens.

Family PECTINIDÆ.

The Pectiniform shells of the Carboniferous period have been referred to various genera by different authors. Phillips described his specimens as *Aracula* and *Pecten*. Portlock used the term *Pecten*, but referred one fine example to *Orthis*. McCoy subdivided his species among the genera *Pecten*, *Aracula*, *Lima*, *Mallus*, *Meleagrina*, *Pterinea*, and *Monotis*; but later on he proposed the new genus *Aciculopecten*, to which he referred the majority of Carboniferous Pectiniform shells. The type of this new genus was *A. planoradiatus*, which subsequently

proved to be the left valve of a species previously described by M'Coy as *Pecten tabulatus*. He also defined the genus *Streblopteria*, the type of which is *S. lævigata*, and he retained *Pecten* and *Amusium*. De Koninck in 1885 referred the Pectiniform shells from the Carboniferous Limestone of Belgium to *Rutotia*, *Streblopteria*, *Aviculopecten*, *Limatulina*, and *Entolium*. Of these it seems that *Rutotia* is a synonym of *Eumicrotis*, Meek, and *Entolium* of *Syncyclonema*, Meek.

Still, however, the shells referred to *Aviculopecten* were evidently diverse in character, and when describing the Lamellibranchs from the Devonian rocks of the State of New York, Hall found it necessary to subdivide them, retaining *Aviculopecten* for shells of the type of *A. planoradiatus*, M'Coy, with large well-formed ears, but separating under the name of *Pterinopecten* shells with an anterior ear only and a very long hinge-line, *Lyriopecten* for shells with a shorter hinge-line and a small anterior ear, and *Crenipecten* for shells with a crenulated hinge-plate. This was a good advance, and two at least of these new genera are represented in Carboniferous times.

Even thus *Aviculopecten* seems to me to include heterogeneous groups, and at least the smooth shells described by Phillips as *Pecten ellipticus* and *P. anisotus*, with very small posterior ears, should be removed. De Koninck placed the latter group with *Streblopteria*, but this genus has no posterior ear, hence I propose to refer smooth, ovate, *Pecten*-like shells, with a smooth, grooved hinge-line, well-marked anterior ear, but short and small posterior ear, often showing flat colour-bands, to *Pseudamusium*, H. and A. Adams, as restricted by Verrill. I have also found that shells possessing characters of *Amusium* occur in Carboniferous times, and hence refer certain species to this genus.

I have also obtained from Carboniferous rocks a series of Pectiniform shells, which I cannot refer to any described genus. One has the valves smooth and very oblique, a very short hinge-line, the posterior part of the valves excavated, and the right valve the more gibbose. For this I propose the name *Obliquipecten*. Specimens occur at Settle, Castleton, and Narrowdale.

The following genera of Pectiniform shells are retained in the family Pectinidæ on account of the well-marked anterior ear in the right valve of each of them:—*Aviculopecten*, M'Coy; *Crenipecten*, Hall; *Pterinopecten*, Hall; *Obliquipecten*, Hind; *Pseudamusium*, H. and A. Adams; *Streblopteria*, M'Coy; *Eumicrotis*, Meek; *Amusium*, Klein; and *Syncyclonema*, Meek.

Palæolina and *Limatulina* are placed in the family Limidæ, though I am not sure that the former is not nearer to *Spindylus* than to *Lima*. As to species, those of Sowerby are all retained, namely, *Aviculopecten plicatus*, *Pterinopecten pupyracens*, and *P. granosus*. Fleming is responsible for *A. dissimilis*. Fourteen of the species described by Phillips are retained; one only, *P. arenosus*, the type of which has been lost, is regarded as the young form of *A. dissimilis*, Fleming. I

consider J. de Carle Sowerby's species *A. gentilis* to be good, but have doubts as to the value of *P. scalaris* of this author.

McCoy described as new seventy-five species of Pectiniform shells in his earlier work, and sixteen of these were founded on right valves. Many of his specific names are synonyms, representing opposite valves or different stages of growth of the same shell. Several of the types are too poor to recognise their true affinity, and several others had been previously described by other writers, while two species, *Avicula pulchella* and *Pecten flabellulum*, do not belong to the family. Of these two shells the first is a fragment of *Pteronites persulcatus*, and the second, I think, the interior of *Athyris planosulcata*. I am able to retain only about twenty species.

In his second work, McCoy described three other species, *Aviculopecten docens*, *A. planoradiatus*, and *A. Ruthveni*. The first is Portlock's *Pecten semicostatus*. The second species, founded on a left valve, had been previously described by McCoy as *P. tabulatus*; and the last species, retained for the present, seems to me to be probably a damaged and full-grown specimen of *A. interstitialis*, Phillips. De Koninck described three species of *Pecten* and twelve species under the genus *Avicula* in his early work, 1842; but in 1885 he described eleven species of *Rutotia*, sixteen species of *Streblopteria*, forty-six species of *Aviculopecten*, five species of *Eutolium*, and six species of *Limatulina*, a very large number of which I regard as synonyms, either representing different stages of growth or simple variations, not of specific value.

The study of the family of *Pectens*, as represented in Carboniferous beds, has been very troublesome owing to the poor material and the difficulty of obtaining specimens well enough preserved to study the important details. The surface-ornament of shells belonging to different genera is often so similar that, unless the hinge-line, and especially the ears, are present, a correct determination of the affinities of the shell is almost impossible. In addition, the hinge-plate is rarely if ever exposed even in the larger specimens. The poor and imperfect condition of many of the types has also caused a difficulty; and to this and the non-recognition of opposite valves of the same shell is due the inordinately large number of supposed species described.

Genus EUMICROTIS, Meek, 1864.

EUMICROTIS, Meek, 1864. Amer. Journ. Sci., 2nd ser., vol. xxxvii, p. 218.

— Meek and Hayden, 1865. Pal. Upper Missouri, p. 53 (Smithsonian Contrib. Knowl., vol. xiv, No. 5).

RUTOTIA, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 196.

Generic Characters.—Shell suborbicular, slightly oblique, the left valve moderately tumid, without ears. The right valve flattened, with a small anterior ear.

The anterior border somewhat convex, the lower much so, but the posterior nearly straight. The hinge-line straight, much shorter than the antero-posterior diameter. The umbo of the right valve small and scarcely projecting above the hinge-line; that of the left much larger, elevated, gibbose, and incurved. Right valve deeply indented by the byssal notch, which forms a triangular pit, and separates a small ear from the rest of the valve. In the left valve, the notch is indicated by a more or less marked depression.

Interior.—Meek states that the adductor scar is large and subcentral, while the impressions of retractor muscles are several, small, and placed near the beaks, and the hinge is edentulous.

Exterior.—The surface is adorned with concentric lines of growth, and in some species with radiating more or less scaly ribs, the more distinct on the left valve.

Observations.—The genus *Eumicrotis* was defined by Meek to include shells from the Permian and Upper Carboniferous of North America. He considered that *Monotis speluncaria*, Schlotheim, sp., and King, from the Permian of England, also belonged to his new genus, and that it had been wrongly referred to *Monotis*, Bronn. This species, however, has a peculiar posterior lobe separated from the rest of the valve by an oblique sinus; the left umbo is arched to a greater extent, and the hinge-line is not so pronounced as in *Eumicrotis*. The type is *Eumicrotis Havni*.

Meek and Hayden say that "the shells embraced in this genus are apparently most nearly allied to *Aucella* of Keyserling." De Koninck established the genus *Rutotia* to receive shells from the Carboniferous Limestone which were smooth, inequivalve, orbicular or oval, with the left valve more convex and higher than the right; but he did not realise that the genus *Eumicrotis*, Meek, had been founded for similar shells, and therefore had the right of priority. De Koninck described eleven species, some of which represent different stages of growth of a single species. His figures of *E. hemisphaericus*, Phill., sp., are not good, and do not show the characters of the anterior and posterior superior angles.

The most common species is *E. hemisphaericus*, Phillips, sp., and it shows the peculiar generic characters described by Meek and Hayden. There can be no doubt of the propriety of separating *P. hemisphaericus* from *Pecten*, and on account of the inequality of the valves it could not be placed in *Posidonomya*. The shell has certainly no connection with *Aviculopecten*. Unfortunately the hinge characters have not yet been observed, but it would appear that there is in the right valve an internal ridge (leaving a groove in casts), which passes from the front of the umbo to the anterior border, forming a curve with the concavity upwards; while in the left valve is a deep narrow hollow externally between the umbonal margin and the rudimentary anterior ear (Pl. VII, fig. 5). Unfortunately this portion of the valve is not complete in the only bivalved example I have yet obtained.

EUMICROTIS HEMISPHERICUS, *Phillips*, sp., 1836. Plate VII, figs. 1—6.

PECTEN HEMISPHERICUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 16.

POSIDONOMYA HEMISPHERICA, *de Koninck*, 1843. Descr. Anim. Foss. Belg., p. 142, pl. i, fig. 16.

AVICULA HEMISPHERICA, *Brown*, 1849. Illust. Foss. Conch., p. 160, pl. lxxv, fig. 5.

AVICULOPECTEN HEMISPHERICUS, *Morris*, 1854. Cat. Brit. Foss., 2nd edit., p. 164.

RUTOTIA HEMISPHERICA, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 197, pl. xxxix, figs. 6, 7.

Cf. STREBLOPTERIA PRÆLINEATA, *de Koninck*, 1885. Ibid., p. 204, pl. xxxii, fig. 4.

Specific Characters.—Shell of medium size, suborbicular, a little inequilateral, very inequivalve, the right valve only slightly convex, the left gibbose. The anterior inferior margin convex, the posterior almost straight and nearly vertical. The hinge-line straight, the smallest, antero-posterior diameter of the valve, making well-marked right angles with the anterior and posterior margins. The umbones subcentral, that of the right valve being small and not elevated, the left being gibbose, elevated, and arched over that of the right valve. No posterior ears, but the valves compressed at the antero- and postero-superior angles, especially the latter, which is the larger and more pronounced. The right valve deeply marked by a triangular pit, which runs up almost to the umbo, for the byssus, and marks off a small ear from the rest of the valve; left not cut, but showing a more or less well-marked depression forming a swollen lobe in the position of the anterior ear. Both valves more convex in the anterior than in the posterior portion.

Interior.—Details not observed.

Exterior.—The surface is marked with very fine microscopic lines of growth, sometimes squamous, best seen in the upper part of the valve, but to the naked eye it is almost smooth.

Dimensions.—Pl. VII, fig. 1, a bivalved example from Hill Bolton, measures—

Antero-posteriorly	.	.	.	37 mm.
Dorso-ventrally	.	.	.	42 mm.
From side to side	.	.	.	18 mm.

Localities.—England: the upper beds of the Carboniferous Limestone of Castleton, Derbyshire; Settle, Hill Bolton, Yorkshire; Narrowdale, Staffordshire; and Poolvash, Isle of Man. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Clogherbrian, co. Kerry.

Observations.—The type of *Phillips's Pecten hemisphaericus* is fortunately preserved in the Gilbertson Collection at the Natural History Museum, South

Kensington, and a new drawing of it is given in the accompanying Pl. VII, fig. 2. Phillips says that "it may possibly be *Avicula*," but de Koninck was the first observer who recognised the distinctive characters of the shell and separated it under his new genus *Rutotia*. Unfortunately, shells belonging to the genus had been recognised and described previously from Permian beds under the name of *Eumicrotis*, and this must therefore have precedence.

The type specimen is a left valve, which shows the ear-like process in front and the absence of any posterior ear. I have fortunately been able to obtain some right valves, which show a fairly well-formed though small anterior ear, separated from the rest of the valve by a deep and broad notch for the byssus. Pl. VII, fig. 1, represents a bivalved example with the right anterior ear wanting, from the Carboniferous Limestone of Hill or El Bolton, Craven district of Yorkshire. Pl. VII, fig. 4, shows the right valve, with the anterior ear well preserved.

E. hemisphæricus is very like the shell I figured as *Posidoniella gibbosa* in Vol. I, Pl. V, figs. 12—14. I should not feel it an easy task to determine the left valves, but fig. 12 shows both valves to have been equally gibbose, and the right valve seems to have had no ear.

EUMICROTIS OVALIS, de Koninck, sp., 1885. Plate XI, figs. 8, 9; Plate XVIII, figs. 8, 9.

RUTOTIA OVALIS, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 200, pl. xxii, figs. 36, 40.

— *ORNITHOCEPHALA*, de Koninck, 1885. Ibid., p. 200, pl. vii, figs. 29, 30; pl. xxii, figs. 25, 29.

Specific Characters.—Shell below medium size, slightly inequivalve, slightly obliquely ovate, gibbose. Its margins rounded. The hinge-line straight, not extending very far backwards. The umbones comparatively large, gibbose, pointed, incurved, twisted slightly forwards; the left only slightly more gibbose than the right, subcentral, separated by an area. The anterior ear well formed in the right valve and separated by a byssal slit from the rest of the valve, not so well marked in the left valve. The posterior ears obsolete, the posterior superior edge of the valve being small; the angle very obtuse.

Interior. Unknown.

Exterior.—The surface is smooth, even concentric lines of growth being hardly visible.

Dimensions.—Pl. XVIII, figs. 8 and 9, a bivalved example from Settle, measures—

Antero-posteriorly	.	.	.	24 mm.
Dorso-ventrally	.	.	.	25 mm.
From side to side	.	.	.	14 mm.

Localities.—England: the Carboniferous Limestone of Settle, Yorkshire; Castleton, Derbyshire. Ireland: co. Cork.

Observations.—I can see no sufficient reason for the recognition of the two species, *Rutotia ovalis* and *R. ornithocephala*, de Kon., and therefore have adopted the first of them. *E. ovalis* can be easily recognised by its large, obliquely twisted umbones, and small posterior wing.

Genus STREBLOPTERIA, *McCoy*, 1851.

- STREBLOPTERIA, *McCoy*, 1851. Ann. Mag. Nat. Hist., ser. 2, vol. vii, p. 170.
 — — 1855. Brit. Pal. Foss., p. 482.
 — Meek and Worthen, 1866. Geol. Surv. Illinois, vol. ii, Palæont.,
 p. 332.
 — de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi,
 p. 202.
 — Miller, 1889. N. Amer. Geol. and Palæontol., p. 514.
 — Tornquist, 1896. Fossilführ. Untercarbon. Südvogesen, Abh. geol.
 Spezialkarte Elsass-Lothringen, Band v, Heft 5, p. 60.

Generic Characters.—Valves ovate, or rotund, the anterior side extended obliquely forwards. The anterior ears small, well defined, and separated from the valve by a deep slit for the byssus. The posterior wing broad, undefined, nearly rectangular, extending as far as the posterior margin of the shell. Valves gently convex, equivalent (*de Koninck*).

Interior.—With a short narrow tooth diverging slightly from the hinge-line on the posterior side of the umbones. Ligament internal, lodged in a simple narrow facet along the hinge-margin. Adductor muscle-scar large, single, shallow, placed posterior to the middle line and high up in the valve.

Exterior.—Surface smooth or with radiating ridges.

Type species.—*Streblopteria lævigata*, *McCoy*.

Observations.—The genus *Streblopteria* was established by *McCoy* for *Pecten*-like shells, with a compressed quadrate posterior wing, having a single tooth in the hinge and an obliquely expanded anterior side. To this genus he referred two species alone, namely, *S. lævigata* and *S. pulchella*, the latter only known by a mere fragment, which on examination proves to be the extreme anterior end of *Actinopteria*, probably *A. persulcata*, *McCoy*. De Koninck doubted the generic characters of this shell. Meek and Worthen, accepting the genus, propose to extend it to receive shells without the peculiar backward obliquity of the typical species of "*Streblopteria*," but they state that the presence of a cardinal tooth in the smooth shells they propose to include in the genus is not ascertained. They

decide to include in *Streblopteria*, "smooth little Carboniferous and Permian species, which seem to have generally, if not always, a deep sharply-defined byssal sinus in the anterior margin of the right valve."

These authors propose to refer to this genus such forms as *Pecten dissimilis* and *P. consimilis*, M'Coy, and refer an American species, previously described by themselves as *P. tenuilineatus*, to the genus.

I cannot think it wise to extend the genus *Streblopteria* to receive shells with well-marked posterior ears, especially when Meek and Worthen state in their description, "posterior wing broad, undefined, nearly rectangular, extended nearly as far as the posterior margin of the shell," and I cannot admit that their shell belongs to this genus. It is difficult to understand on what grounds they would refer *P. dissimilis*, with its well-marked ears and its strongly ribbed character, to *Streblopteria*. *Pecten consimilis*, M'Coy, a synonym of *Pecten anisotus*, Phillips, has a small, not extended, well-defined posterior ear, and therefore not belonging to this genus, from which it also differs in being ovate and having no expanded anterior margin.

De Koninck accepted M'Coy's genus and described eighteen species, of which I think *S. elongata*, M'Coy, sp., *S. prælineata*, *S. picta*, *S. pullus*, *S. ellipsoideus*, *S. propinqua*, having well-marked posterior ears, do not belong to the genus. I am not prepared, however, to accept all the other species, as I suspect some of them represent different stages of growth of the same shell. I find that the length of the hinge-line and the development of the posterior wing vary greatly with each stage of growth.

Streblopteria seems to form a passage between *Posidoniella* and *Posidonomya* and a more strictly Pectiniform type. The two former genera have no anterior ear, or a very rudimentary anterior ear respectively, but both have a rectangular expanded posterior wing. *Eumicrotis*, too, would seem to come even between *Posidoniella* and *Streblopteria*, because in that genus the right valve has a well-marked anterior ear, separated by a deep and long slit for the byssus from the rest of the valve. There is no evidence that *Posidonomya* was byssiferous, but *Posidoniella* often occurs in numbers attached to fossil vegetable remains.

STREBLOPTERIA LEVIGATA, M'Coy, 1855. Plate XI, figs. 1—7.

MELEAGRINA LEVIGATA, M'Coy, 1844. Synops. Carb. Foss. Ireland, p. 80, pl. xii, fig. 5.

AVICULOPECTEN LEVIGATUS, Morris, 1854. Cat. Brit. Foss., 2nd edit., p. 165.

STREBLOPTERIA LEVIGATA, M'Coy, 1855. Brit. Pal. Foss., p. 482.

— — — de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 203, pl. xxxii, figs. 2, 3; pl. xl, figs. 14, 15.

Specific Characters.—Shell above medium size, obliquely suborbicular, expanded anteriorly, flattened and produced at the posterior superior angle. The left valve convex, the right less so. The margin forming a single varying curve from the anterior ear to the posterior superior angle, but the posterior margin having a less curvature than the right. The hinge-line straight, very short in front and prolonged backwards. The anterior ears small and triangular, compressed and sharply defined, that of the right valve deeply slit for the byssus. No posterior ear, but a rectangular expanded wing-like process. The umbones tumid, pointed and incurved, gibbose, with a more sudden slope in front than behind, subcentral.

Interior.—Unknown.

Exterior.—The surface is smooth, but the microscope shows very fine concentric lines of growth, and the anterior ears have fine concentric, almost obsolete, intricate markings. One specimen shows about 8—10 narrow, widely separated radiating colour-bands.

Dimensions.—Pl. XI, fig. 4, from Lowick, in the Woodwardian Museum, measures—

Antero-posteriorly	.	.	.	.	97 mm.
Dorso-ventrally	.	.	.	.	97 mm.

Localities.—England: the Carboniferous Limestone of Lowick and Settle. Ireland: the Carboniferous Limestone of Caherass and Doohylebeg, co. Limerick; Cork, co. Cork; Millicent, co. Kildare; Cloghran, co. Dublin.

Observations.—This species must be regarded as the type of *Streblopteria*, McCoy, and demonstrates the absence of a posterior ear, so that the genus must be limited to shells with this character.

A very large specimen from Lowick (Pl. XI, fig. 4) is perfect except the anterior ear, but shows very well the character of the posterior superior angle and hinge-line. It is a right valve. The left valve is more gibbose than the right, and its anterior ear comparatively more depressed. The hinge-plate has not been exposed, and I am unable to say anything on this subject. In young examples the valve is comparatively more gibbose and the umbonal gibbosity more oblique.

Pl. XI, fig. 6, represents a specimen which has the colour-bands preserved. It is from the dark limestone of Cloghran, co. Dublin. The opposing valve of the same specimen (Pl. XI, fig. 5) shows the anterior ear, the shell posterior to the umbo having been broken.

STREBLOPTERIA ORNATA, *R. Etheridge, jun.*, sp., 1873. Plate XI, figs. 10—12.

AVICULOPECTEN ORNATUS, <i>R. Etheridge, jun.</i> , 1873.	Mem. Geol. Surv. Scotland,
— — — — —	Expl. Sheet 23, p. 103.
— — — — —	Geol. Mag., vol. x, p. 346,
	pl. xii, fig. 2.

Specific Characters.—Shell of medium size, compressed, subcircularly quadrate, inequilateral. The left valve more convex than the right valve. The anterior and lower margins of the shell regularly rounded, the posterior almost straight and oblique. The hinge-line straight and prolonged backwards, making a well-marked, almost a right angle with the posterior margin. The umbo of the left valve large and swollen, pointed and incurved, overlapping that of the right valve, which is small, flattened, and not raised. The anterior ear small, triangular, and well defined in the right valve; depressed and somewhat rolled in the left valve. No posterior ears, but the posterior superior angle of the valves flattened and expanded in the form of a rectangular wing.

Interior.—Unknown.

Exterior.—The surface is ornamented with close, concentric lines, which are crossed on the anterior side by fine, flexuous, radiating striæ. The posterior wing is almost smooth. The anterior ear of the right valve has a few well-marked radiating ribs.

Dimensions.—Pl. XI, fig. 11, a left valve, measures—

Antero-posteriorly	.	.	.	28 mm.
Dorso-ventrally	.	.	.	28 mm.

Localities.—Scotland: the Lower Limestone series of Kinghorn, Fife; Calderwood Limestone series of Waygateshaw Pit, Carluke; between Avon Paper Mill and Linlithgow Bridge; River Gryfe, near Crosslea Mill, near Houston. Also, according to Etheridge, the Upper Limestone series of several localities and horizons. Ireland: the Carboniferous series of Fair Head, co. Antrim; Rathkeale, co. Limerick.

Observations.—Mr. R. Etheridge, jun., founded this species and figured a right valve (*op. cit.*, 1873). The anterior ear of the type specimen seems to be detached; otherwise the figure of it is a good one.

The absence of a posterior ear removes the species from *Aviculopecten*, with which it has in other respects little or no affinity, and affirms its relationship to *Streblopteria*. I have been able to study the left valve from specimens in the collection of the Geological Survey of Scotland, which have been generously placed at my disposal for the purpose. It is considerably more gibbose than the right

valve. Several specimens of the left valve are crushed and have lost their original shape, and are therefore misleading as to their condition when living.

S. ornata is easily distinguished from *S. hemisphaerica* by the presence of flexuous radiating striae in front, and from *S. laevigata* by its more rounded shape and the concentric linear ornament.

Genus PTERINOPECTEN, *Hall*, 1884.

PTERINOPECTEN, *Hall*, 1884. Pal. N. York, vol. v, pt. i, Lamell., p. xii.

Generic Characters.—Shell Pectiniform, hinge-line long. Posterior ears not well defined, being simple expansions or extensions of the upper lateral margins to the hinge-line. Test ornamented with rays, ears having the same ornament as the rest of the valve, and both valves having an almost identical adornment.

Observations.—There can be no doubt of the propriety of separating shells with a prolonged hinge-line and indefinite posterior ears from *Aviculopecten*, McCoy; for the type species of this genus is *A. planoradiatus*, which was described with *A. Ruthveni* when the genus *Aviculopecten* was originally diagnosed in the 'Annals and Magazine of Natural History,' 2nd series, vol. vii. Hall recognises *Pterinopecten* in beds of Devonian age in North America, and it seems to have persisted until Middle Coal Measure times in England; but the genus is not rich in species, one single species only being found above the Carboniferous Limestone *massif* and its equivalent, the Yoredale Rocks of Wensleydale and the North.

Zittel has evidently mistaken the type of *Aviculopecten*, for he figures and describes *P. papyraceus* as the type, instead of *A. planoradiatus*, which proves to be the left valve of a shell previously described by McCoy as *P. tabulatus*.

PTERINOPECTEN PAPYRACEUS, *Sowerby*, sp., 1823. Plate VII, figs. 7—13.

PECTEN PAPYRACEUS, *Sowerby*, 1823. Min. Conch., vol. iv, p. 75, t. 354.

AVICULA PAPYRACEA, *Goldfuss*, 1834-40. Petref. Deutschl., vol. ii, p. 126, t. 116, fig. 5.

PECTEN PAPYRACEUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 213.

AVICULA PAPYRACEA, *de Koninck*, 1842-4. Anim. Foss. Terr. Carb. Belg., p. 136, pl. v, fig. 6.

PECTEN SUBPAPYRACEA, *de Verneuil*, 1845. Géol. Russie d'Europe, p. 325, pl. xxi, fig. 3.

AVICULA PAPYRACEA, *Brown*, 1849. Illust. Foss. Conch., p. 159, pl. 61**, fig. 11.

AVICULOPECTEN PAPYRACEUS, <i>Morris</i> , 1854.	Cat. Brit. Foss., 2nd edit., p. 165.
— — — <i>McCoy</i> , 1855.	Brit. Pal. Foss., p. 488.
— — — <i>Salter</i> , 1864.	Mem. Geol. Surv., Country round Oldham, pl. i, fig. 1.
— — — <i>Baily</i> , 1875.	Char. Brit. Foss., pl. xxxix, fig. 1.
— — — <i>Roemer</i> , 1876.	Lethæa Geogn., taf. 44, fig. 1.
— — — <i>R. Etheridge, jun.</i> , 1876.	Geol. Mag., dec. 2, vol. iii, p. 152, pl. vi, fig. 7.
— — — — —	1877. Ibid., vol. iv, p. 243, pl. xii, figs. 4, 5.
— — — <i>MOSENSIS, de Koninck</i> , 1885.	Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 214, pl. xxxvi, fig. 20.
— — — <i>PAPYRACEUS, Wild</i> , 1892.	Trans. Manch. Geol. Soc., vol. xxi, p. 395, pl. iii, fig. 12.

Specific Characters.—Shell semi-oval, inequilateral, slightly oblique towards the posterior side, the left valve very moderately convex, the right valve much less so. The anterior border very slightly convex, the lower strongly curved, the posterior convex below and concave above. The hinge-line straight and long, the longest antero-posterior diameter of the valve. Umbones small, and only slightly tumid, the right less swollen than the left, placed about two-fifths the length of the hinge-line from the anterior end. The anterior ears more definite than the posterior, that of the right valve being the more distinct and separated from the valve by a deep groove, which is represented at the margin by a deep notch for the byssus. The left ear convex, not incised, margin only slightly notched. The posterior ears not marked off from the rest of the valve, and only indicated by the gradual compression of the valve. The postero-superior angle extending slightly beyond the rest of the margin, so that the border of the valve shows a slight concavity just below it.

Interior.—Unknown.

Exterior.—The surface is ornamented with many somewhat irregular, flattened, radiating ribs, secondary ribs often arising between the original ones, which pass without dividing to the border. At times these ribs are decussated by lines of growth, which vary much in degree in individual shells. Ears have a similar ornament to the rest of the valve, but the lines of growth are much more marked in these positions. The number and closeness of the ribs also vary. The ribs are separated by smooth, flattened spaces.

Dimensions.—Pl. VII, fig. 13, a left valve from the Lower Coal Measures of Southowram, measures—

Antero-posteriorly	.	.	.	.	60 mm.
Dorso-ventrally	.	.	.	.	53 mm.
Convexity of left valve	.	.	.	.	5 mm.

Localities.—England: specially characteristic of the series of beds which succeed the *massif* of Carboniferous Limestone, and found at many horizons as high as the Middle Coal Measures. Derbyshire: Pendleside series of Mam Tor, river Noe, near Castleton, and Railway Cutting, Tissington; Coal Measures between top hard coal and deep soft coal, Midland Railway Cutting, $\frac{3}{4}$ mile north of Pilsley Junction. Staffordshire: Pendleside series of river Dane, in Swythamley Hall gardens, Quarry near Mixon Hey, and the Coombes, near Leek; Coal Measures of Chedale Coalfield (above stinking coal); roof of thin coal about 42 yards above Tilborne Coal; Pottery Coalfield (above 7 ft. Banbury, and at Weston Coyney brick works, and below the Twist Coal). Lancashire: Pendleside series of Pendle Hill, Dinckley Hall, river Hodder; above the Bullion Coal, Sholver, Colne, and universally; 150 yards over Great Mine, Ashton-under-Lyne. Cheshire: Pendleside series, E. of Bosley Minn. Shropshire: Pennystone Ironstone of Coalbrookdale. Yorkshire: Pendleside series of the Vale of Todmorden, Pule Hill, Marsden; Flasby and Burnsall Fells; below the third grits at Eccup, and Wadsworth Moor; Coal Measures of Halifax (roof of the Hard bed), and universally at that horizon. North Wales: Holywell Shales of Flintshire. Isle of Man: *Posidonomya*-beds, Poolvash. Scotland: $2\frac{1}{2}$ feet above the Calderwood Cementstone, Lower Limestone Group, East Kilbride; and ? above the Ell Coal, Wishaw. Ireland: Pendleside series (Upper Limestone Shales) of co. Dublin; Meath; Glenaster, Foynes Island, and Mount David, co. Limerick; Roscliffe, co. Clare; Coal Measures of Firoda Colliery, Kilkenny; Gannister series of Castlecomer.

Observations.—This species is most important, as it is the characteristic Lamelli-branch of a special fauna, and therefore of zonal value. Its zone is very thick, measuring some 2000—4000 feet in some areas, but *Pterinopecten papyraceus* appears in the lower beds of this mass of rocks, and recurs at several horizons throughout the series, which extends from the top of the *massif* of Carboniferous Limestone to a layer high up in the Coal Measures. The species has been long known, and it has been fully described by Sowerby, de Koninek, Mc'Coy, and Etheridge. The slight differences which occur in the descriptions by these authors are doubtless all due to different degrees of preservation in the specimens studied. To this matter Mr. R. Etheridge, jun., has called attention. Very frequently *P. papyraceus* is much compressed, but the true characters of the shell are best observed in specimens preserved in nodules of black limestone. Well-preserved specimens always show a well-marked anterior ear in both valves, but the posterior ear is not marked off from the valve by a groove, and its margin extends slightly beyond the rest of the valve, so that the posterior border is sinuous above.

The marking of the shell is simple; a series of long, radiating, narrow ribs which pass uninterruptedly from the umbo to the border of the valve, is separated by smaller ribs which commence on the body of the valve between any two main

ribs. I have not noticed one rib dividing or coalescing with another. The concentric lines of growth are rarely very distinct, but they are occasionally so well marked as to interrupt the radiating ribs and cause a more or less widely reticulate appearance. I am unable to agree with Mr. R. Etheridge, jun., that the radiating ridges frequently bifurcate. I have never seen such a condition, and think he must have been misled by the intercalated ribs, which on careful examination are found to arise independently in the spaces between the primary ribs. The shell varies considerably as to the number and closeness of the radiating ribs. The ribs are strongest and widest apart on the posterior ears.

A personal examination of the type specimen of *Aviculopecten Mosensis*, de Koninck, leaves no doubt in my mind that the latter name is a synonym of *P. papyraceus*. The matrix of the fossil is a black limestone, and therefore not the Visé Limestone. It belongs to a horizon at Visé above the *massif*, and indicates beds of the Pendleside series.

I also think that the *Avicula Samuelsii* of Brown, described and figured in 'Trans. Manch. Geol. Soc.,' vol. i, 1841, p. 225, pl. vii, fig. 65, is the young of *P. papyraceus*.

PTERINOPECTEN CONCAVUS, *McCoy*, sp., 1884. Plate IX, figs. 6, 7.

PECTEN CONCAVUS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 90, pl. xv, fig. 10.

AVICULOPECTEN CONCAVUS, *McCoy*, 1854. Brit. Pal. Foss., p. 484, pl. 3 E, fig. 2.

Specific Characters.—Shell of medium size, transversely quadrato-orbicular, only moderately convex. The anterior, inferior, and lower part of the posterior margin convex, the upper part of the posterior border sinuous. The umbones small, pointed, not raised. The hinge-line long and straight. The anterior ears long, large, and well defined, especially in the right valve, the posterior ears not well marked off from the body of the valve, long, their depth indicated by an extension of the posterior border in a falciform manner.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous close, fine, rounded, radiating ribs, new ones becoming intercalated between them as they pass towards the margin of the valve. The ears are ornamented in the same way as the rest of the valve. The ribs are crossed by concentric lines of growth, which are here and there more or less deeply marked, best seen at the posterior border and posterior ear, where the radiating striae are interrupted by them.

Dimensions.—Pl. IX, fig. 6, the type of *Aviculopecten concavus*, *McCoy*, measures —

Antero-posteriorly	.	.	.	.	94 mm.
Dorso-ventrally	.	.	.	.	76 mm.

Localities.—England: the Carboniferous Limestone of Lowick, Northumberland. Ireland: Arenaceous Carboniferous Limestone of Killogunra, Killala.

Observations.—This species has been described on two occasions by M'Coy. The type used for the second description is from Lowick, and is in the collection of the Woodwardian Museum, Cambridge. The specimen is a left valve, re-figured in Pl. IX, fig. 6, and I regard it as much crushed and flattened. In the same collection and from the same locality are two other specimens, one being a right valve (Pl. IX, fig. 7), which is moderately convex, and as this valve is always less gibbose than the left valve in all known species of the genus, it is reasonable to suppose that the apparent flatness of the left valve is merely accidental. M'Coy says that "this large species has the left valve *concave outwardly* in most specimens, . . . in which it differs from all other Palæozoic species. The opposite valve is slightly more convex," etc., etc. The ears have fine radiating ribs, being marked exactly in the same way as the body of the valve.

This shell might be mistaken for *Aviculopecten semicircularis*, M'Coy, sp., if the ears were not exposed; in the latter species the posterior ears have no radiating ribs, are better marked, and are almost smooth and much depressed.

PTERINOPECTEN RADIATUS, *Phillips*, sp., 1836. Plate IX, figs. 12—16.

AVICULA RADIATA, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 211, pl. vi, fig. 8.

— BOSQUETIANA, *de Koninck*, 1851. Descr. Anim. Foss. Terr. Carb. Belg., Suppl., p. 682, pl. lvii, fig. 3.

AVICULOPECTEN BOSQUETIANUS, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 215, pl. xxxv, figs. 29, 30.

Specific Characters.—Shell below medium size, almost semicircular, very slightly and transversely oblique, inequilateral, inequivalve, the right valve being almost flat and the left somewhat convex. The anterior and inferior borders convex, the posterior convex below, sinuous above. The hinge-line straight and long. The umbones small, that of the left valve the more convex, pointed, and placed a little posterior to the junction of the anterior and middle thirds of the hinge-line. The anterior ears well defined, that of the left side marked off from the rest of the valve by a sudden more or less deep oblique sulcus, which in some specimens is almost obsolete. The same sulcus more pronounced in the right valve. Posteriorly the ears not marked off in any way from the rest of the valve, but formed by a gradual compression of the valve in this position, and their limit marked at the posterior margin by a projection of the posterior superior angle and the portion of the valve immediately beneath it.

Interior.—Unknown.

Exterior.—The surface is ornamented by simple, distinct ribs of variable

number, which pass from the umbo to the margin, becoming broader as they approach the free edge of the valve, and separated from each other by shallow grooves, in which secondary ribs may arise, these being intercalated between the primary ones. The ribs show small tumefactions at intervals in their course. The ribs are coarser and wider apart towards each extremity. Concentric lines of growth are seen crossing the valves at irregular intervals.

Dimensions.—Pl. IX, fig. 14, measures—

Antero-posteriorly	50 mm.
Dorso-ventrally	40 mm.
Convexity of valve (left)	3·5 mm.

Localities.—England: the Carboniferous Limestone (upper beds) of Settle, Yorkshire; Castleton, Park Hill, and Thorpe Cloud, Derbyshire. Ireland: Carboniferous Limestone of St. Doulagh's, co. Dublin; Little Island, co. Cork; Kildare.

Observations.—The type of Phillips's *Avicula radiata* is a very small shell, and it is not difficult to understand why the species has not been recognised by authors. The type specimen (Pl. IX, fig. 16) is preserved in the Gilbertson Collection, Natural History Museum, South Kensington, and is a very young stage of growth of the left valve. An examination of any of the larger examples and a study of the contour of a young example by comparing the lines of growth, show that Phillips's shell has exactly the same contour as the young stage of de Koninck's *Aviculopecten Bosquetianus*. I am therefore compelled, on the grounds of priority, to retain Phillips's name instead of that given by de Koninck. I have seen specimens of the right valve, which is very flat, but have met with none which were sufficiently well preserved to be figured. This species has been described and figured under the name of *A. Bosquetianus* on two occasions by de Koninck, who obtained his specimens from Visé. Although de Koninck stated that this species occurred in Bolland, it has not been inserted in any British list of fossils from the Carboniferous Limestone so far as I can ascertain. Referring to this species in a foot-note, de Koninck alludes to the essential identity of the shell with the Devonian species referred by Hall to *Pterinopecten*, but he hesitates to accept any subdivision of the genus *Aviculopecten*.

Pterinopecten radiatus resembles *P. papyraceus* more closely than any other shell, but the nodular character of the ribs and the more transverse shape form an important and easily recognised difference between the two species. Pl. IX, fig. 13, represents a peculiar variety of *P. radiatus*, in which the ribs are few and wide apart, due to the fact that only in very few places have intercalating or secondary ribs been formed. Another peculiarity in this specimen is the well-defined anterior ear separated from the body of the valve by a deep groove. It belongs possibly to another species, but I hesitate to describe a new species from a single specimen.

PTERINOPECTEN GRANOSUS, *Sowerby*, sp., 1827. Plate X, figs. 1—3, 6.

		PECTEN GRANOSUS, <i>Sowerby</i> , 1827. Min. Conch., p. 144, pl. dlxxiv, fig. 2.
?	—	— <i>Portlock</i> , 1843. Rep. Geol. Londonderry, pp. 436, 437.
	—	— <i>McCoy</i> , 1844. Synops. Carb. Foss. Ireland, p. 93.
	—	— <i>Brown</i> , 1849. Illust. Foss. Conch., p. 154, pl. lxxv, fig. 16.
		AVICULOPECTEN GRANOSUS, <i>Morris</i> , 1854. Cat. Brit. Foss., 2nd edit., p. 164.
	—	— <i>McCoy</i> , 1855. Brit. Pal. Foss., p. 486.
	—	— <i>Baily</i> , 1875. Figs. Char. Brit. Foss., p. 113, pl. xxxix, fig. 2.
Non	—	— <i>de Koninck</i> , 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 213, pl. xxxvi, figs. 11, 12.
	—	— <i>nodosus</i> , <i>de Koninck</i> , 1885. Ibid., p. 211, pl. xxxvii, figs. 6, 12—15.
	—	— <i>BLANDUS</i> , <i>de Koninck</i> , 1885. Ibid., p. 216, pl. xxxiii, figs. 25, 26; pl. xxxvi, fig. 29.

Specific Characters.—Shell attaining a fair size, obliquely suborbicular. Antero-posterior and dorso-ventral diameters almost equal. Inequivalve, almost equilateral. The left valve moderately convex, the right nearly flat. The anterior and inferior borders convex, the posterior convex below, sinuous above. The hinge-line straight, equal in length to the greatest transverse diameter of the valve. The umbones placed in front of the centre of the hinge-line, that of the left valve tumid and slightly raised, that of the right valve small and inconspicuous. The anterior ears well marked, triangular, pointed, separated from the valve by a well-defined groove, and projecting beyond the anterior border. The posterior ears not marked off from the valve. The upper border of the posterior ear produced backwards and pointed, its margin falcate.

Interior.—The hinge-plate is elongate, narrow, and transversely striate.

Exterior.—The surface is ornamented with numerous radiating ribs, distinctly tuberculated or moniliform, separated by folds, the surface of which is transversely striate. Secondary ribs arise in the grooves between the main ribs, and in large full-grown examples as many as three fine moniliform ribs are seen between the larger ones. In small shells the ribs are more numerous, finer, and closer together. Concentric lines of growth cross the ribs, some being strongly marked, and always well developed in the position of the posterior ear.

Dimensions.—Pl. X, fig. 2, from the Carboniferous Limestone of Clitheroe, measures—

Antero-posteriorly	.	.	.	65 mm.
Dorso-ventrally	.	.	.	60 mm.
Elevation of left valve	.	.	.	10 mm.

Localities.—England: the Carboniferous Limestone of Clitheroe, Lancashire; Hill Bolton and Settle, Yorkshire; Castleton, Kniveton, and Glutton Dale, Derbyshire; Lowick and Redesdale (Redesdale Ironstone), Northumberland. Scotland: Lower Carboniferous of Eskdale, Dumfriesshire; Pathhead, Haddingtonshire. Ireland: Carboniferous Limestone of Clane, co. Kildare; Woodlands and Malahide, co. Dublin; Clogherbrian, co. Kerry; Banteer, co. Cork.

Observations.—The type specimen is preserved in the Sowerby Collection, Natural History Museum, South Kensington, and it is re-figured in Pl. X, fig. 6. It is the left valve of a small specimen, and has lost a part of the posterior superior angle, but shows the depressed anterior ear. The ribs are closer and more numerous than often occurs. De Koninck completely mistook the shell, the specimen figured and described by him as *Aviculopecten granosus*, Sow., probably not belonging to the same genus. The shell does occur in Belgium at Visé, and was described under the name of *A. nodulosus*, de Koninck. This author describes the ears of his *A. granosus* as being about of equal size, which is not the case. De Koninck criticises Phillips's figured specimen of *Pecten granosus*, and perhaps with some justice, unless, perchance, it was imperfect in the region of the ears. The description, however, meagre though it be, rather agrees with that of Sowerby's shell. Unfortunately the type has disappeared, so the matter cannot be now determined.

I have been fortunate enough to obtain specimens with both valves in contact, and one specimen showing the hinge-line (Pl. X, fig. 3). The right valve is almost flat, as de Koninck states to be the case in his shell, *A. nodulosus*. There is a certain amount of variation in the ornamentation of different specimens of this species, owing to the non-development of secondary or tertiary ribs, and the strength and number of the nodular swellings on them. Judging from the shape and condition of the very young shell of *P. granosus* as shown by the deeply marked line of growth in the specimen drawn in Pl. X, fig. 2, *Aviculopecten blandus*, de Koninck, represents this condition. The shape, alternate nodular ribs, and length of hinge-line are identical. I have therefore placed this specific name in the list of synonyms. De Koninck's type was obtained from Visé, the locality of *A. nodulosus*, de Kon. *P. granosus* is distinguished from *P. eximius* by the irregularity of the nodes on the ribs and their distance apart. These nodes are very numerous and close in the latter species, and its shell is altogether of less rugged character than that of the former.

PTERINOPECTEN EXIMIUS, *de Koninck*, sp., 1885. Plate X, figs. 4, 5; Plate XI, figs. 13, 14.

AVICULOPECTEN EXIMIUS, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 211, pl. xxxvii, figs. 1, 2, 4, 5.

Specific Characters.—Shell of medium size, suborbicular, the right valve flattened, the left moderately gibbose. The margin of the valve orbicular, curved, without a break from the base of each ear. The hinge-line straight, long, produced posteriorly along the upper border of the posterior ear, and pointed. The anterior ear the shorter, triangular, marked off from the valve by a well-marked groove in the left, and by a slit in the right valve. The posterior ear not marked off from the rest of the valve, but represented by a compression and extension of the shell, so that in the upper part of the posterior border its contour is falcate.

Interior.—Unknown.

Exterior.—The surface is covered with radiating ribs, between each pair of which a second rib soon rises and gradually increases in strength; halfway across the valve a third set of ribs arises, one between each primary and secondary rib. The ribs are often in pairs, a large and a small one close together, and then an interval. They are studded with close, rounded nodules, less apparent over the posterior false ear. Concentric lines of growth are also seen passing across the ribs.

Dimensions.—De Koninck's type specimen measures—

Antero-posteriorly	.	.	.	85 mm.
Dorso-ventrally	.	.	.	75 mm.
Length of hinge-line	.	.	.	75 mm.

Localities.—England: the Carboniferous Limestone of Derbyshire. Ireland: Lower Limestone Shales of Clonakilty, and Carboniferous Limestone of Little Island, co. Cork; St. Doulagh's, co. Dublin.

Observations.—This species is distinguished from *P. granosus* solely by its ornament. Possessing the same general shape and size, the ornament is much more regular, the ribs closer and more numerous, and the nodules on the ribs rounder and closer than in the latter species. De Koninck describes the three classes of radiating ribs, but he does not state that the secondary ribs may very soon assume the same size as the primary ribs, so that at the margin of the valve they are not to be distinguished. I have only seen one British example—a specimen of a portion of the left valve from Derbyshire, in the Woodwardian Museum, Cambridge (Pl. X, fig. 4).

I am not persuaded of the value of *P. eximius* as a species, and think it very

likely to have been a rather ornamented form of *P. granosus*. De Koninck contrasts his species with *A. Ruthveni*, M'Coy, sp., with which it has no affinity, the latter shell belonging to another type of the genus, and *Aviculopecten nodulosus*, de Koninck, which is *P. granosus*, Sow., sp. A specimen from the Lower Limestone Shales of Clonakilty, co. Cork (Pl. XI, fig. 14), was erroneously identified by Baily as *Aviculopecten papyraceus*, and was so labelled in the collection of the Geological Survey of Ireland. Pl. XI, fig. 13, represents a fine specimen of a right valve in the Woodwardian Museum, Cambridge.

PTERINOPECTEN RIGIDUS, M'Coy, sp., 1844. Plate VIII, figs. 1—3.

ORTHIS UMBRACULUM, *Portlock*, 1843. Rep. Geol. Londonderry, p. 456, pl. xxxvii, fig. 5.

MELEAGRINA RIGIDA, M'Coy, 1844. Synops. Carb. Foss. Ireland, p. 80, pl. xiii, fig. 16.

Cf. MALLEUS ORBICULARIS, M'Coy, 1844. Ibid., p. 87, pl. xix, fig. 2.

Specific Characters.—Shell of medium size, obliquely suborbicular, the left valve moderately convex. The anterior end small above but expanding below, with a very convex, thickened border. The inferior border rounded, the posterior border convex below, sinuous above, and thin. The hinge-line straight and prolonged backwards. The umbones moderately convex and pointed, that of the left valve slightly raised above the hinge-line and placed far forwards. The anterior ear in the left valve short, badly defined, its antero-superior angle pointed. That of the right valve unknown. The posterior ear not marked off from the valve, but the valve compressed and expanded into the prolonged hinge-line, and the posterior border concave just below the postero-superior angle.

Interior.—The adductor muscle-scar is shallow, large, and in the same position as in *Meleagrina*. The hinge-plate is broad and long, extending from the antero-superior angle for a little more than two-thirds the length of the hinge-line. It is marked by transverse ridges and grooves, three or four in number, which in the region of the umbo are bent upwards to form a very wide angle. This hinge-plate is placed obliquely, the lower edge projecting considerably more inwards than the upper edge. Immediately below the hinge-plate, in front, is a smooth, shallow furrow, which separates the thickened anterior edge from the plate and corresponds with the byssal opening in the right valve.

Exterior.—The surface is ornamented by numerous slightly raised, narrow, rough, rounded, radiating, distant ribs, which pass from the umbo to the margin. Between these primary ribs other finer ribs arise at intervals, and there may be from one to three of these between the original ribs, commencing at different levels

down the shell. The whole of the radiating ribs are crossed at intervals by more or less well-marked concentric lines of growth, which may be strong enough to interrupt the ribs. This condition is best marked on both ears.

Dimensions.—Pl. VIII, fig. 3, as restored, measures—

Antero-posteriorly	85 mm.
Dorso-ventrally	75 mm.
Convexity of left valve	10 mm.

Localities.—Ireland: co. Fermanagh, in Shales at Enniskillen; Lisnapaste, Ballintra, co. Donegal; Millicent, co. Kildare.

Observations.—It is difficult to understand why Portlock referred this species to *Orthis*, as the Aviculoid character of the shell is very apparent, and it possesses no Brachiopod-like character. The type specimen is exceedingly valuable, and is preserved in the Museum of the Geological Survey, Jermyn Street. It is a specimen of a left valve (Pl. VIII, fig. 3), entirely free from matrix, but has lost some half-inch of the lower part of its circumference and the extremities of the ears. Its hinge-line, however, is intact, and a view of this is given in Pl. VIII, fig. 3a. This hinge-line recalls very forcibly the hinge-plates of *Myalina* and *Naiadites*, and to a certain extent of *Leptopteria* and *Pterinea*. Hall figures a specimen of *Lyriopecten* (a genus which is characterised by a hinge-line of a length intermediate between that of *Pterinopecten* and *Aviculopecten*), *L. orbiculatus*, from the Upper Helderberg and Hamilton Groups of New York, and possessing a similar hinge-plate to that shown in *P. rigidus* ('Pal. New York, Lamelli-branchiata,' vol. i, pl. iv, figs. 7 and 9). The shape of *P. rigidus* shows its strong resemblance to recent forms of *Melcagrina*, which possess a hinge-plate differing only slightly from their Palæozoic congener.

The type of *Melcagrina rigida*, M'Coy, is unfortunately not in the Griffith Collection of the Museum of Science and Art, Dublin, but I have no hesitation in referring Portlock's shell to M'Coy's species. M'Coy's description of the ribs is as follows:—"Surface with sixty-five rather distant, narrow, rough, radiating ridges, crossed by a few large irregular concentric wrinkles. . . . The radiating ribs are narrow, rough, and separated by broad flat spaces." His figure is a good one, and evidently drawn from a perfect specimen. It is much to be regretted that the specimen has disappeared. It seems to me not unlikely that *Mallens orbicularis*, M'Coy, may be the right valve of *P. rigidus*. Unfortunately the type has disappeared, and I have met with no other shell like it. *M. orbicularis* was founded on a flat right valve, with a much-produced and pointed posterior wing, very similar in shape to that of *P. rigidus*, the right valve of which has never been described.

I refer the original of Pl. VIII, fig. 1, with hesitation to the species, on account of its small posterior wing; but noting the lines of growth on the specimen shown

in Pl. VIII, fig. 3, it will be seen that the wing is comparatively smaller in young examples, though not so small as in the specimen under discussion. The general sculpture of the shell has induced me to place it with McCoy's species for the present.

PTERINOPECTEN MELEAGRINOIDES, McCoy, sp., 1844. Plate XVII, figs. 20—23.

PECTEN MELEAGRINOIDES, McCoy, 1844. Synops. Carb. Foss. Ireland, p. 96, pl. xvi, fig. 3.

Specific Characters.—Shell of medium size, truncato-orbicular, convexity of the left valve more than that of the right valve. The anterior and lower borders rounded, the posterior truncate, nearly straight, slightly falcate above. The hinge-line straight, of moderate length. The umbones broadly tumid and pointed, placed in front of the centre of the hinge-line. The anterior ear of the left valve depressed and well defined from the valve, comparatively small and triangular. The anterior ear of the right valve separated from the valve by a deep and long byssal slit, the ear comparatively narrow and of moderate length. No posterior ear, but each valve compressed and flattened into the postero-superior angle, which is not produced, the hinge-line being only slightly pointed.

Interior.—Unknown.

Exterior.—The surface of both valves is ornamented with alternately large and small, round, radiating ridges, the larger ribs only rising at the umbo. The spaces between the ribs are crossed by concentric ridges, much less strong than the radiating ribs. Towards the posterior superior angle the ribs are wider apart and the intervening surface smoother. The anterior ears are almost smooth in the left valve, but concentrically imbricate in the right.

Dimensions.—Pl. XVII, fig. 22, from Thorpe Cloud, measures—

Antero-posteriorly	.	.	.	28 mm.
Dorso-ventrally	.	.	.	22 mm.

Localities.—England: the Carboniferous Limestone of Thorpe Cloud and Castleton, Derbyshire. Ireland: no locality is given in Griffith's list for this shell ('Journ. Geol. Soc. Dub.,' vol. ix, p. 106).

Observations.—Unfortunately the type of *P. meleagrinoides*, McCoy, has disappeared, but, judging from the figure and description, I think there need be no doubt of the propriety of referring my specimens to this species. *P. meleagrinoides* is distinguished by its short hinge-line posteriorly, in this point differing from other species of the genus, to which, however, it must be referred, because it has no defined posterior ear.

I have been fortunate enough to find both valves, and, as in other species of the

genus, the ornament is practically the same on each, though its character is stronger on the left and more convex valve. From *P. rigidus*, *P. meleagrinoideus* is distinguished by its smaller amount of obliquity, its tessellated ornament, and short posterior side.

PTERINOPECTEN TESSELLATUS, *Phillips*, sp., 1836. Plate IX, figs. 8—11.

- AVICULA TESSELLATA, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 211, pl. vi, fig. 6.
 — — — *de Koninck*, 1843. Descr. Anim. Foss. Terr. Carb. Belg.,
 p. 134, pl. vi, fig. 2.
 MELEAGRINA TESSELLATA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 81.
 AVICULA TESSELLATA, *Brown*, 1849. Illust. Foss. Conch., p. 162, pl. lxvi**, fig. 31.
 AVICULOPECTEN TESSELLATUS, *Morris*, 1854. Cat. Brit. Foss., 2nd edit., p. 166.
 — — — *de Koninck* (pars), 1885. Ann. Mus. Roy. d'Hist.
 Nat. Belg., tom. xi, p. 218, pl. xxxiii, figs. 33, 34.

Specific Characters.—Shell small, somewhat semicircular, the left valve moderately gibbose, the right flattened, inequilateral. The anterior and inferior borders rounded, the posterior being broadly rounded below, slightly concave above. The hinge-line long and straight. The umbones placed in front of the middle line, the left one gibbose and slightly raised, pointed, the right small, flattened, and not raised. The anterior ear in the left valve well defined and rolled, in the right valve long, severed from the valve by a long, deep slit for the byssus. The posterior ears not well marked off from the valve, postero-superior angle produced.

Interior.—Unknown.

Exterior.—The surface of the valve is ornamented by few widely separate rounded ribs, slightly moniliform where crossed by lines of growth; rarely fine secondary ribs arise in the flattened, smooth spaces between the primary ribs, towards the lower margin. The ribs are crossed by well-marked, almost equidistant, concentric lines of growth, giving the valve a tessellated appearance, less well marked on the ears than elsewhere.

Dimensions.—A fairly perfect left valve, shown in Pl. IX, fig. 11, measures —

Antero-posteriorly	19 mm.
Dorso-ventrally	17.5 mm.
Elevation of valve	4 mm.

Localities.—England: the Carboniferous Limestone of Settle, and Shales above the "massif," Whitewell, Yorkshire; Castleton and Thorpe Cloud, Derbyshire. Ireland: Carboniferous Limestone of Little Island and Ballinabointra, co. Cork; Ardshanbally, co. Limerick.

Observations.—The type specimen of *P. tessellatus*, Phillips, sp., is preserved in the Gilbertson Collection, Natural History Museum, South Kensington, and I am permitted to re-figure it in Pl. IX, fig. 10. It is a left valve, not quite complete posteriorly, but the restored contour was correctly indicated in Phillips's figure already quoted. I have been fortunate enough to meet with a right valve in the Burrows Collection of the Woodwardian Museum, Cambridge, which, however, has lost its anterior ear. I have also figured (Pl. IX, fig. 9) a perfect but young example from the collection of Mr. J. Wright. It is rather smoother, but has a similar ornament to that possessed by the left valve.

Incomplete specimens of *P. tessellatus* may be easily confounded with *A. nobilis*, de Koninck, which has much the same ornament; but the latter shell has the shorter hinge-line of *Aviculopecten*, and belongs to that genus. Its shape is more generally ovate, and has a definite but shorter posterior ear than the present species.

PTERINOPECTEN CYCLOPTERUS, *Phillips*, sp., 1836. Plate XVII, figs. 15—19.

AVICULA CYCLOPTERA, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 211, pl. vi, fig. 5.

Specific Characters.—Shell small, the left valve gibbose, the right flattened, with flattened and produced ears, U-shaped. The hinge-line straight and produced at each end, the longest diameter of the shell. Umbo swollen, incurved, and pointed, twisted slightly forwards, placed a little in front of the centre. Ears not well defined, gradually compressed and expanded, the posterior larger than the anterior ear.

Interior.—Unknown.

Exterior.—The surface is ornamented with few distant, radiating ribs, hardly elevated above the rest of the valve, secondary ribs arising in large examples towards the lower margin of the valve. These ribs are crossed by strong, concentric, rounded, distant folds, which are continued up to the hinge-line, and strongly marked on each ear.

Dimensions.—Pl. XVII, fig. 15, the type, a left valve, measures—

Antero-posteriorly	.	.	.	.	23 mm.
Dorso-ventrally	.	.	.	.	23 mm.

Localities.—England: the Carboniferous Limestone of Yorkshire (Bolland). Ireland: the Carboniferous Limestone of Little Island, co. Cork; Dromore, co. Limerick.

Observations.—The type specimen is a left valve (Pl. XVII, fig. 15) preserved in the Gilbertson Collection, Natural History Museum, South Kensington. For a

long time I was doubtful as to the value of this species, and could find no other specimens. However, in Mr. Wright's cabinet I observed a series of four small shells which are certainly like Phillips's shell, and have a peculiar and characteristic ornament. The type seems to have lost most of its shell, and to be in the form of a cast of the interior, but the test over the posterior ear remains. The ornament is of a very open basket-work character. One of Mr. Wright's specimens shows both valves, and the right valve proves to be flat, with much the same ornament as the left valve.

The generic affinity of this species is not very certain, but the absence of posterior ear and the length of its hinge-line have induced me to place it for the present under *Pterinopecten*.

PTERINOPECTEN DUMONTIANUS, *de Koninck*, sp., 1843. Plate VIII, figs. 4—8;
Plate XIV, figs. 1, 2.

PECTEN DUMONTIANA, *de Koninck*, 1843. Descr. Anim. Foss. Terr. Carb. Belg.,
p. 134, pl. iv, fig. 3.

AVICULA VALENCIENNESIANA, *de Koninck*, 1851. Ibid., Suppl., p. 681, pl. lvii,
fig. 2.

AVICULOPECTEN DUMONTIANUS, *Morris*, 1854. Cat. Brit. Foss., 2nd edit., p. 164.

— — — *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat.
Belg., tom. xi, p. 212, pl. xxxvii, fig. 3.

Specific Characters.—Shell above medium size, the left valve subrotundato-trapezoidal, moderately convex, the right valve much less so. Antero-posterior diameter less than dorso-ventral diameter, but variable. Anterior margin more rounded than the posterior margin, which is sinuous above and falciform immediately below the upper margin. The hinge-line straight, elongate, produced backwards, and pointed. The umbones gibbose, small, pointed and incurved, much less marked in the right valve, and placed at the junction of the anterior and middle thirds of the hinge-line. The anterior ear depressed, well marked off from the valve, triangular, its margin rounded, of fair size; the posterior ear not marked off from the valve, but continuous with the compressed and expanded postero-superior angle of the valve, with which it is incorporated.

Interior.—Unknown.

Exterior.—The surface of the left valve is ornamented with many thick, nodular, radiating ribs, which alternate with somewhat thinner ones, crossed by occasional concentric undulations of growth. The anterior ear is marked transversely by about six radiating ribs, crossed by numerous concentric lines of growth. In the right valve the alternately large and small radiating ribs are more numerous, closer,

and finer in size, still nodulose. The anterior ear is crossed by radiating ribs, separated from the valve by a hollow space marked by concentric lines. On the posterior ear the ribs are large and further apart than on the valve.

Dimensions.—Pl. VIII, fig. 8, a specimen from Settle, in the Woodwardian Museum, Cambridge, measures—

Antero-posteriorly 61 mm.

Dorso-ventrally 68 mm.

Localities.—England: the Carboniferous Limestone of Settle, Yorkshire; Castleton, Derbyshire; Lowick, Northumberland.

Observations.—*P. Dumontianus* is more coarsely ribbed than *P. granosus*, and the ribs are not so regularly punctate. It is not so gibbous as *A. Ruthveni*. Fragments may be easily mistaken for *A. Murchisoni*, but the latter has markedly alternate strong and fine nodular ribs, while its hinge-line is comparatively short, with both ears, especially the posterior, well defined and much depressed. I have fortunately obtained a specimen with both valves (Pl. VIII, figs. 5, 5a), whereas hitherto only the left valve has been described. The ornamentation varies to a considerable extent in different individuals. A fine specimen with both valves, in the Manchester Museum, Owens College, is figured on Pl. XIV, figs. 1, 2.

Genus AVICULOPECTEN, McCoy, 1851.

AVICULOPECTEN, McCoy, 1851. Ann. Mag. Nat. Hist., 2nd ser., vol. vii, p. 171.

— — (pars), 1854. Brit. Pal. Foss., p. 392.

— Hall, 1883. Pal. N. York, vol. v, pt. i, Lamell., p. xii.

Non — Zittel, 1900. Text-book Palæont. (Trans.), p. 380.

Generic Characters.—Shell inequivalve, almost equilateral, ovate. Umbones well marked, swollen, and pointed, especially in the left valve. Ears well defined and large, the posterior often produced along its upper border and pointed. Hinge-line moderately long.

Interior.—The hinge-plate is striated longitudinally and very narrow. The adductor scar is large, and placed high up in the valve and posterior to the middle line.

Exterior.—The surface of the valves is ornamented with radiating ribs and concentric lines, more or less well marked, and often nodular, punctate, or imbricated. The right valve nearly always marked somewhat differently from the left. The ears always marked by few radiating ribs, separated by smooth, hollow spaces, which show fine concentric lines of growth.

Observations.—The type species of *Aviculopecten*, McCoy, was *A. planoradiatus*,

the left valve of the shell previously described by him as *Pecten tabulatus*. M'Coy included in his genus shells which are now separated under *Pterinopecten*, Hall, and, as understood by him, it evidently included shells of widely different characters. De Koninck followed M'Coy, and refused to accept Hall's genus *Pterinopecten*, or *Euchondria*, Meek; and Zittel, taking *P. papyraceus* as the type of *Aviculopecten*, seems to have been of the same view.

I think, however, there can be little or no doubt as to the wisdom of dividing ovate shells with well-marked posterior ears from semicircular forms with posterior ears undefined. In *Aviculopecten* the right valve is always flatter than the left, and has a different marking. The tendency is for the radiating ribs to be best marked in the left valve, and concentric lines in the right valve. In *Pterinopecten* the right valve is almost flat, but the ornament is essentially the same as that of the left valve, though it may be less strongly marked.

Aviculopecten seems to have been richer in species than any of the other Pectiniform genera found in Carboniferous rocks.

AVICULOPECTEN TABULATUS, M'Coy, 1844. Plate XII, figs. 1—4.

PECTEN TABULATUS, M'Coy, 1844. Synops. Carb. Foss. Ireland, p. 100, pl. xvi, fig. 12.

AVICULOPECTEN PLANORADIATUS, M'Coy, 1851. Ann. Mag. Nat. Hist., ser. 2, vol. vii, p. 171.

— — — 1855. Brit. Pal. Foss., p. 489, pl. 3 e, fig. 8.

? — — R. Etheridge, jun., 1876. Geol. Mag., dec. 2, vol. iii, p. 151.

Specific Characters.—Shell of medium size, triangularly pyriform, left valve gibbose, the right valve much less so. The ears large and depressed, the anterior triangular, in the right valve separated from the body of the valve by a deep groove, and rolled, in the left valve flattened and depressed. The posterior ear large, flattened, much hollowed by an oblique groove at its junction with the body of the valve, and having the upper border much produced, and its border markedly falcate. The lower margin of the posterior ear descending and cutting the posterior border a little below half the dorso-ventral diameter. The lower margin of the valve rounded; the anterior margin below the ear almost straight, directed obliquely forwards and downwards. The hinge-line straight and very long. The umbones swollen, incurved, central in relation to the body of the valve; the left umbo the more swollen.

Interior.—The internal surface is smooth, except near the lower margin, where

it is obscurely ribbed, the ribs being broad and flat, separated by narrow grooves. The hinge-plate is narrow and long; starting from a point at each extremity, it very gradually widens as far as the middle line, apparently quite smooth. The adductor muscle-scar is large, ovate, and placed high up in the valve, but posterior to the median line.

Exterior.—The surface is adorned with many simple, unequal, smooth, broad, flattened, radiating ribs, separated by almost linear grooves. The two valves are very similar. The anterior ears are obscurely radiate; the posterior ears have many radiating ribs, but exhibit two or three stronger ribs near the upper border, the whole being concentrically striated.

Dimensions.—Pl. XII, fig. 1, the type specimen, measures—

Antero-posteriorly	55 mm. +
Dorso-ventrally	64 mm.

Localities.—England: the upper beds of the Carboniferous Limestone of Castleton and Park Hill, Derbyshire; Hill Bolton and Settle, Yorkshire; Poolvash, Isle of Man. Ireland: Carboniferous Limestone of Ballintrillick, Bundoran.

Observations.—I am convinced that *Pecten tabulatus*, M'Coy, the type of which is a portion of a right valve showing the ears, is the right valve of *A. planoradiatus* of the same author. I re-figure the specimen (Pl. XII, fig. 2). M'Coy's description reads: "Surface of the shell with about fifteen flat ribs, separated by very narrow, deep sulci." I regard the flattened broad ribs and the large posterior ears as very distinctive specific characters. The type of *A. planoradiatus*, M'Coy, is in the Woodwardian Museum, Cambridge, and I am permitted to re-figure it (Pl. XII, fig. 1). It is a left valve, which has lost part of its posterior ear and much of the valve, and therefore does not give a correct idea of the length of its hinge-line. Pl. XII, fig. 3, represents a left valve more perfect in this respect, and shows that the convexity of the lower border is continued until it meets the hollow separating the body of the valve from the posterior ear, and is not as is shown in M'Coy's original drawing. I have been able to examine the hinge-plate, and in this character *A. tabulatus* agrees with *A. semicostatus*, Portlock, sp. The right valve differs from the left in being somewhat flatter and having the anterior ear deeply slit for the byssus.

Mr. R. Etheridge, jun., describes the broad flattened ribs of this species as being "covered by concentric, somewhat irregular, wavy, more or less imbricating scales," and also as having colour-markings of a "widely zigzag pattern." I have not been able to recognise these characters in any of the numerous specimens of *A. tabulatus* which have passed through my hands, and think that a shell of some other species must have been mistaken for the one in question.

AVICULOPECTEN SEMICOSTATUS, *Portlock*, sp., 1843. Plate XIII, figs. 9—15.

- PECTEN PLICATUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 21.
 — SEMICOSTATUS, *Portlock*, 1843. Rep. Geol. Londonderry, p. 436, pl. xxxvi, fig. 9.
 — FLEXUOSUS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 93, pl. xviii, fig. 1.
 AVICULOPECTEN DOCENS, *McCoy*, 1855. Brit. Pal. Foss., p. 485, pl. 3 E, figs. 6, 7.
 — ILLEGALIS, *McCoy*, 1885. Ibid., p. 486.

Specific Characters.—Shell of medium size, the left valve moderately convex, the right much less so, nearly orbicular. Ears strongly defined, the anterior depressed, a little shorter than the posterior, falcate, and pointed. The anterior ear in the right valve small, rolled, and separated from the rest of the valve by a deep, broad depression for the byssus. The umbo of the right valve markedly triangular, pointed, and not raised, that of the left valve more gibbose, pointed, and slightly raised.

Interior.—The adductor muscle-scar is large and shallow, placed high up and just posterior to the middle line. The hinge-plate is broadly diamond-shaped, obscurely striated longitudinally. The internal surface is smooth in the umbonal region, but there are gradual indications of the radiating ribs, which become strongly marked near the margin.

Exterior.—The surface is ornamented with numerous simple, somewhat irregular, rounded, radiating ribs. Secondary ones often arising in the spaces between the primary, and continuing to the margin. The ribs are crossed by occasional concentric lines of growth. The posterior ear is crossed by markedly strong concentric folds parallel with the margin, and has three or four radiating ribs very lightly marked or almost obsolete. The anterior ear has both radiating and concentric striæ, the former faintly seen on the internal cast.

Dimensions.—Pl. XIII, fig. 9, the type specimen, measures—

Antero-posteriorly	.	.	.	40 mm.
Dorso-ventrally	.	.	.	38 mm.

Localities.—England: the Carboniferous Limestone of Lowick, and the Redesdale Ironstone, Northumberland; the Carboniferous Limestone of Castleton, Derbyshire, and Poolvash, Isle of Man. Ireland: the Carboniferous Limestone of Ballygasey, Loughgall, co. Armagh; Carnteel, co. Tyrone; St. Doulagh's, co. Dublin.

Observations.—The type of *Portlock's Pecten semicostatus* is the cast of the interior of a left valve, preserved in the Museum of the Geological Survey, Jernyn

Street (Pl. XIII, fig. 9). Its posterior ear, however, is wanting. On comparing this specimen with the type of M'Coy's *Aviculopecten docens* (Pl. XIII, fig. 14), which is in the Jenkinson Collection of the Woodwardian Museum, there can be no doubt of the identity of the two shells. M'Coy's type is also a cast of a left valve, and does not exhibit the radiating ribs on the posterior ear figured by him; but he figures another specimen from the Carboniferous Limestone of Derbyshire, which has some of the external characters preserved. In his account of *A. docens*, M'Coy mentions the fact that the shell is identical with his *Pecten flexuosus*, but owing to the preoccupation of that name it was necessary to introduce another. M'Coy's description is very good and accurate.

The specimen figured by Phillips as *P. plicatus* is no doubt the testiferous example of *A. semicostatus*. I have figured this shell (Pl. XIII, fig. 10), a left valve, almost perfect except part of the anterior ear. I have been fortunate to find a specimen showing a hinge-plate, in the collection of Mr. R. Law. It is a left valve (Pl. XIII, fig. 11), and was obtained at Poolvash, Isle of Man.

AVICULOPECTEN DISSIMILIS, *Fleming*, sp., 1828. Plate XIII, figs. 1—8.

- PECTEN DISSIMILIS, *Fleming*, 1828. Hist. Brit. Anim., p. 387.
 — — *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 17.
 — ARENOSUS, *Phillips*, 1836. Ibid., p. 212, pl. vi, fig. 20.
 — OTTONIS, *Portlock*, 1843. Rep. Geol. Londonderry, p. 436, pl. xxxvi, fig. 10.
 — ARENOSUS, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 89.
 — CELATUS, *M'Coy*, 1844. Ibid., p. 90, pl. xviii, fig. 2.
 — CONCENTRICO-STRIATUS, *M'Coy*, 1844. Ibid., p. 91, pl. xiv, fig. 5.
 — DISSIMILIS, *M'Coy*, 1844. Ibid., p. 91.
 — EUGULOSUS, *M'Coy*, 1844. Ibid., p. 98, pl. xvii, fig. 7.
 ? — UNDULATUS, *M'Coy*, 1844. Ibid., p. 101, pl. xvii, fig. 12.
 — SUBFIMBRIATUS, *de Verneuil*, 1845. Geol. Russie de l'Europe, p. 327, pl. xxi, figs. 5 a, b.
 ARENOSUS, *Brown*, 1849. Illust. Foss. Conch., p. 156, pl. lxx, fig. 10.
 AVICULOPECTEN CELATUS, *M'Coy*, 1855. Brit. Pal. Foss., p. 483, pl. 3 e, fig. 5.
 — — *R. Etheridge, jun.*, 1876. Ann. Mag. Nat. Hist., ser. 4, vol. xviii, p. 97.
 — — *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 225, pl. xxxviii, figs. 5—8.
 — TEXTILIS, *de Koninck*, 1885. Ibid., p. 225, pl. xxxiv, fig. 30.

Specific Characters.—Shell of medium size, suborbicular, with large ears. The right valve gently convex, the left more so. The margin subcircular. The

hinge-line straight. The umbones almost central, not elevated, triangularly acute, the left the more swollen. The anterior ear with its rounded margin joining the shell at an angle with the anterior border, well defined from the body of the valve. The posterior ear produced along its upper margin, falcate as to its posterior border, defined from the valve by a slight oblique groove.

Interior.—The internal surface is almost smooth, but with radiating ribs near the margin in the left valve, and with concentric rugæ in the right. The adductor muscle-scar is large, rounded, placed high up and posterior to the median line. The pallial line is well marked, remote from the border. The hinge-plate is narrow, elongate, and smooth.

Exterior.—The left valve is ornamented with numerous, close, radiating ribs, closely set with arched imbricated scales, the spaces between the ribs being also imbricate. The right valve, on the other hand, is marked by numerous, close, concentric, crenated ridges, which, in some examples, are decussated by obscure radiating lines.

The anterior ear is crossed by about five radiating ribs, diminishing in size from above downwards. The upper four ribs are placed in the upper half of the ear. The anterior ears are reticulate, having radiating ribs, crossed by well-marked concentric lines of growth.

Dimensions.—Pl. XIII, fig. 1, a left valve, from Corrieburn, measures—

Antero-posteriorly	.	.	.	56 mm.
Dorso-ventrally	.	.	.	61 mm.

The internal cast of a bivalved example of similar size measures 15 mm. from side to side.

Localities.—England: the Carboniferous Limestone of Lowick and the Four Laws Limestone, Northumberland; Castleton, Derbyshire; Narrowdale and Wetton, Staffordshire; the Red Limestone at the top of the Yoredale Series, Leyburn, Yorkshire; Underset and Main Limestone, Farcote Gill, Swarth Fell; same horizon, Nine Standards Rigg, Westmoreland; Poolvash, Isle of Man. Scotland: the Upper Limestone series of Garngad Road; the Lower Limestone series of Beith; Hind og Glen, Dalry; Corrieburn, Pathhead, Haddingtonshire; Arniston Glen, South Esk, Midlothian. Ireland: the Carboniferous Limestone of Armagh and Redbarn, co. Armagh; Cookstown, co. Tyrone; Cork and Little Island, co. Cork; Clogherbrian, co. Kerry; Ballingarrane, co. Limerick.

Observations.—Fleming gave no figures of his species, but his description is as follows:—"Suborbicular, slightly lengthened, right or lower valve with numerous ribs, slightly scaly. Ears nearly equal, ribbed transversely and longitudinally. Left or upper valve concave, regularly marked concentrically with flat obsolete ribs, which become scaly on crossing the longitudinally ribbed ears."

For right valve read left; and for left, right, and the description is exactly that

which describes *A. cælatus*, M'Coy. I suppose that by a concave left or upper valve Fleming was either thinking of the interior, or had a crushed specimen, as I know of no Carboniferous Pectiniform shell with a valve concave externally. Phillips figured both valves of what he took to be *Pecten dissimilis*, one of which, the right valve, is preserved in the Gilbertson Collection of the Natural History Museum, South Kensington. This shell (Pl. XIII, fig. 5) has the peculiar marking of the right valve beautifully preserved, though unfortunately much of the ears has been broken off. Whether or no the specimen figured as the left valve belongs to the same species is doubtful, and Phillips placed a query before it. The specimen having disappeared, it is now impossible to say more about this point.

There can be no doubt that the shell described by M'Coy as *A. cælatus* is the left valve of Fleming's species, for several specimens of bivalved examples from Beith, Ayrshire, in the collection of Mr. J. Neilson, of Glasgow, demonstrate the fact that the left valve of *A. cælatus*, M'Coy, and the right valve of *Pecten dissimilis*, Fleming, are one and the same species. It is to be noted that *A. cælatus*, M'Coy, was founded on a left valve, and that author makes no mention of the right valve. It is also noteworthy that M'Coy, referring to *P. dissimilis*, considers that Fleming's and Phillips's shells were not the same. There can be little or no doubt that *A. textilis*, de Koninck, is the right valve of *A. dissimilis*, although the former is from the Tournai beds and the latter from Visé. The shape and ornament of the ears, and the ornament of the body of the shell, are identical with what we know to be the right valve of *A. dissimilis*.

P. arenosus agrees with *A. dissimilis* in the character of the ornament of the two valves. The ribs of the former are more numerous, closer, and finer, and the concentric ribs of the right valve comparatively fewer and broader than in the latter. It is possible that the one may only be a juvenile condition of the other.

Mr. R. Etheridge recognised the peculiar character of the right valve, but retained the name *A. cælatus*.

I consider that *P. subgimbratus*, de Verneuil, should be referred to *A. dissimilis*, likewise the shell referred by Portlock to *P. ottonis*. In both of these cases the left valves only were figured or described.

Pecten concentrico-striatus, M'Coy, evidently, and *P. undulatus* probably, are the right valves of *A. dissimilis*. The latter has the posterior ear broken, which therefore appears too short. I also believe *P. rugulosus* to represent a left valve. All three types are in the Science and Art Museum, Dublin.

The type of *Pecten arenosus*, Phillips, has unfortunately disappeared, and I think it probable that it may have been the right valve of a young specimen of *A. dissimilis*, because the meagre description reads—"Radiating striæ very numerous, alternately larger; minutely crenulated with many sharp circular striæ." It is true that "rather short square ears" hardly agree with *A. dissimilis*, but it is

impossible to recognise the species; and there is no wonder that very different shells have hitherto been referred to Phillips's species in different collections.

AVICULOPECTEN PLICATUS, *Sowerby*, sp., 1823. Plate XII, figs. 5, 6, 8, 9.

- PECTEN PLICATUS, *Sowerby*, 1823. Min. Conch., vol. iv, pl. dlxxiv, fig. 3.
 Non — — *Phillips*, 1836. Geol. Yorks, pt. ii, p. 212, pl. vi, fig. 21.
 — — *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 93.
 — *Hians*, *McCoy*, 1844. Ibid., p. 94, pl. xvi, fig. 6.
 — *Micropterus*, *McCoy*, 1844. Ibid., p. 96, pl. xv, fig. 12.
 AVICULA PLICATA, *Brown*, 1849. Illust. Foss. Conch., p. 160, pl. lxx, fig. 8.

Specific Characters.—Shell of medium size, fan-shaped, the body of the valve triangularly ovate, the left valve only moderately convex, the right still less so. The lower margin broadly convex; the posterior margin sinuously curved, due to the falcate posterior ear. The anterior ear smaller, triangular, depressed; the posterior ear large, its upper border extended and pointed, marked off from the valve by an oblique sulcus, the lower part slightly convex, the upper flattened. The hinge-line straight and moderately long. The umbo of the left valve triangular, pointed, and moderately convex; that of the right valve flattened and almost obsolete.

Interior.—Smooth, with obscure radiating ribs towards the margin.

Exterior.—The surface of the left valve is marked with many fine, close, radiating ribs, between which new ones arise as they become separated in the passage across the shell, the whole of which are crossed by subimbricating striæ. The posterior ear is marked with frequent radiating striæ crossed by concentric lines of growth, the ribs being further apart in the centre of the ear than at the upper or lower margin. The anterior ear is adorned in the same manner. The right valve is very similarly ornamented, the secondary ribs, however, being often wanting. The ears partake of the same character of ornament as those of the left valve, but are smoother.

Dimensions.—Pl. XII, fig. 6, *Sowerby*'s type specimen, measures—

Antero-posteriorly	.	.	.	37 mm.
Dorso-ventrally	.	.	.	35 mm.
Gibbosity of left valve	.	.	.	3 mm.

Localities.—England: the Carboniferous Limestone of Richmond, Yorkshire, and Castleton, Derbyshire. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Rathkeale, Kilgrogan, and Nantinan, co. Limerick; Millicent, Clane, co. Kildare; Clonaboy, co. West Meath; St. Doulagh's, co. Dublin.

Observations.—The type of Sowerby's *Pecten plicatus* is preserved in the Sowerby Collection of the Natural History Museum, South Kensington. It is a left valve (Pl. XII, fig. 6), a little damaged at the umbo and posterior ear. It was obtained from Queen's County, Ireland. I have studied the right valve from specimens in the collection of Mr. Joseph Wright, of Belfast, and one of these is figured (Pl. XII, fig. 8). It lies on a slab only slightly separated from a left valve of the same species, and they probably belonged to each other. There is no doubt *Pecten hians*, M'Coy, is identical with Sowerby's species. The diagnosis of the latter is as follows:—"Longitudinally ovate, depressed; ears small, unequal; a very large fold beneath the posterior ear forming a hiatus in the margin. Surface with very numerous, rounded, radiating ridges, alternately larger and smaller, crossed by regular, concentric, imbricating striae. This shell is rendered very remarkable by the large fold on the posterior side," etc. etc. The type of *P. hians*, M'Coy, is in the Griffith Collection, Museum of Science and Art, Dublin. It is a very imperfect example of the left valve, but shows the characteristic posterior fold, which is almost all that remains of the real shell. I have therefore not re-figured it. I regard this peculiarity as typical of *A. plicatus*, Sowerby, sp., and I have hitherto not met with this character in any other Carboniferous species. *P. micropterus*, M'Coy, is a name given to a young specimen of *A. plicatus*, and must be placed amongst the synonyms of this species.

Phillips doubtfully referred a shell to *Pecten plicatus*. I have been able to compare this with the type, and certainly they do not belong to the same species. Phillips's shell (Pl. XIII, fig. 10) is much more convex, the ribs are much stronger, the posterior ear is small and depressed. This shell shows doubtless the external characters of *P. semicostatus* of Portlock, a species founded on an internal cast, to which I now refer it.

AVICULOPECTEN ESKDALENSIS, sp. nov. Plate XII, figs. 7, 10, 11.

Specific Characters.—Shell inequivalve, of medium size, obliquely quadrato-ovate. The left valve moderately convex, the right valve flattened. The margin rounded. The hinge-line straight, almost as long as the transverse diameter. The anterior ear in the right valve well marked, separated from the rest of the valve by a slit for the byssus; the ear in the left valve depressed, rolled, and well defined from the body of the valve. In both valves the posterior ears seem to be merely a depressed portion of the valve, triangular, deep, with the upper border prolonged backwards and the posterior margin falcate. The umbones obtuse, sub-central, not raised.

Interior.—Unknown.

Exterior.—The surface of both valves is covered with numerous somewhat irregular, radiating, angular ribs, a finer rib often arising between two larger ones. In the right valve the ribs are finer and more regular and more uniform in size, and crenulated. The posterior ears are ornamented in the same way as the rest of the valve, there being no real break between the valve and the posterior ear. The anterior ear of the left valve is also crossed by several radiating ribs. The anterior ear of the right valve has its ribs interrupted by scalariform lines.

Dimensions.—Pl. XII, fig. 10, measures—

Antero-posteriorly	.	.	.	33 mm.
Dorso-ventrally	.	.	.	32 mm.

Localities.—Scotland: the Calciferous Sandstone series of river Esk, Glencarholm, Dumfriesshire.

Observations.—This species occurs abundantly and in all stages of growth, in a series of shales at Glencarholm, on the banks of the river Esk, with a very peculiar fauna, which, as a group, has not yet been recognised elsewhere. Fortunately, specimens showing the right and left valves still joined have been obtained. The peculiar nature of the posterior ears of the valve has a good deal in common with that which obtains in *A. plicatus*, Sow., sp., the line of depression marking the ear from the valve being very oblique, and reaching the posterior margin low down. The ribs in *A. plicatus* are much finer, more numerous and regular; and the shape of the valve is more nearly circular and less gibbose than in this new species.

AVICULOPECTEN FALLAX, *McCoy*, sp., 1844. Plate XVII, figs. 28—30.

PECTEN FALLAX, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 92, pl. xiv, figs. 2, 2 a.

Specific Characters.—Shell of only medium size, triangularly suborbicular, very moderately convex, the right valve less so than the left. Margin regularly rounded. Hinge-line straight and long. Umbones central, small, pointed, not raised, gibbose in the left valve, but flattened and almost obsolete in the right. Ears well defined on both sides; the posterior prolonged along its upper border and pointed posteriorly; the anterior ear in the right valve depressed and narrow, separated from the valve by an elongate slit for the byssus, in the left valve triangular, its margin falciform, not reaching as far forwards as the anterior margin of the valve.

Interior.—Smooth, the adductor muscle-scar shallow, rounded, placed high up in the valve and posterior to the middle line.

Exterior.—The right valve is ornamented with several somewhat irregular, coarse, radiating ribs, few and almost obsolete near the umbo, and fresh ribs arise

between each original pair a short distance from the umbo. I cannot make out the ribs to be nodulose, but they are often imbricate near the lower margin. The ribs are present over the posterior ears, but less marked, and are crossed by subimbricating concentric lines.

In the right valve the radiating ribs are more numerous and finer, and almost obsolete radiating ribs are seen on the posterior ear. The anterior ear is concentrically striated.

Dimensions.—Pl. XVII, fig. 29, a right valve from Millicent, co. Kildare, in the Woodwardian Museum, Cambridge, measures—

Antero-posteriorly	.	.	.	.	42 mm.
Dorso-ventrally	.	.	.	.	35 mm.

Localities.—Ireland: the Carboniferous Limestone of Millicent, co. Kildare; and Castleconnell, Doohylebeg, and Gortnagrou, co. Limerick.

Observations.—Two shells, a right and left valve, labelled *Pecten fallax*, are in the Griffith Collection, Museum of Science and Art, Dublin. It seems to me possible that these two specimens may not have originally served as M'Coy's types. They are very poor specimens. The figures must have been largely hypothetical, which to some extent may account for their partial inaccuracy. Although the contour and the hinge-line are correctly drawn in both figures, these details are not shown in the shells. The ears of both valves are well defined and marked off from the valve by an acute angular fold, a character not indicated in M'Coy's figures, and I am unable to see the nodulose character given to the ribs of the left valve in the plate in the (?) original specimen, or in any others which I have examined.

I figure in Pl. XVII, figs. 28—30, the cast of the interior of right and left valves from the collection of the Geological Survey of Ireland, and a fairly perfect right valve in the collection of the Woodwardian Museum, Cambridge.

AVICULOPECTEN SUBCONOIDEUS, *R. Etheridge, jun.*, 1876. Plate XVII, figs. 1—5.

AVICULOPECTEN SUBCONOIDEUS, *R. Etheridge, jun.*, 1876. Ann. Mag. Nat. Hist., ser. 4, vol. xviii, p. 96, pl. iv, figs. 1, 2.

Specific Characters.—Shell of medium size, ovato-quadrata, antero-posterior less than the dorso-ventral diameter. The left valve convex, the right valve flattened. The ears moderately well defined, except the right anterior ear, which is very well marked. The anterior margin sinuous, the inferior broadly curved, the posterior sinuous. The hinge-line straight, not quite as long as the greatest antero-posterior diameter. The umbones small, compressed, flattened, placed a little in front of

the centre of the hinge-line. The anterior ear of the right valve short, triangular, its upper margin prolonged to a point, separated from the valve by a deep, wide byssal notch; the posterior ear flattened, its posterior border falcate, not separated from the valve by a groove, but formed by a gradual compression of the valve. The left anterior ear better defined, compressed, its upper border prolonged and pointed, its anterior margin falcate. The left posterior ear as in the right valve.

Interior.—The hinge-plate is broadly triangular, crossed by transverse grooves. Internal surface smooth near the umbo, but with radiating ribs and sulci near the periphery. Adductor scar large, rounded, placed high up and posterior to the middle line.

Exterior.—The surfaces of the left valve and both ears are marked by many close, raised, flattened, unequal, radiating ribs, which are not so close or numerous on the ears, crossed here and there by concentric lines of growth more frequent on the ears. The right valve has the same character of ornament, but is much less strongly marked, and the anterior ear is almost free from radiating lines.

Dimensions.—Pl. XVII, fig. 5, a left valve, measures—

Antero-posteriorly	.	.	.	32 mm.
Dorso-ventrally	.	.	.	35 mm.
Length of hinge-line	.	.	.	27 mm.

Localities.—Scotland: Calciferous Sandstone series of Newton Quarry, Knockhill, Fife; Wardie Shales, Craigleith Quarry; Carboniferous Limestone series, West Quarry, Salton, and Beucloich, Millburn, Lemnaxtown; Gawkhall Scar, Kirtle Water, Ecclefechan; Whitefield Quarry, west of Machbie Hill Station. Ireland: Carboniferous Sandstone, Carnteel, co. Tyrone; Carboniferous Slate, Lehenagh, co. Cork.

Observations.—*A. subconoideus* is fairly common in the shell beds of Newton Quarry, Knockhill, Fife, whence Mr. Etheridge obtained the specimens he described and figured. The types are small, however, and the left valve is a cast of the interior, while the right valve has only the posterior ear not freed from the matrix. The figured specimens (Pl. XVII, figs. 1—3) are in the Museum of the Geological Survey of Scotland. Mr. Etheridge was correct in separating this species from *Pecten conoideus*, McCoy, which is distinct. This species passes up into the Carboniferous Limestone series. It has been reported from several localities ('Mem. Geol. Surv. Scotland;' 'Geol. Eastern Fife,' 1902, p. 368) both in the Calciferous Sandstone and Carboniferous Limestone series of the east of Scotland.

When large and crushed the shell becomes somewhat distorted, and the line limiting the ears is obliterated.

AVICULOPECTEN PERA, *McCoy*, sp., 1844. Plate XV, figs. 13—15.

PECTEN PERA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 97, pl. xv, fig. 19.
 NON AVICULOPECTEN PERA, *McCoy*, 1855. Brit. Pal. Foss., p. 488.

Specific Characters.—Shell small, quadrato-ovate, inequivalve. The left valve more convex than the right; slightly oblique. Ears large, deep, and well defined; the anterior rectangular, the larger; the posterior pointed. The lower margin rounded; the posterior border more oblique than the anterior border. The hinge-line straight, moderately long. The umbones triangular, moderately gibbose, pointed, subcentral.

Interior.—Unknown.

Exterior.—The left valve is ornamented by numerous irregular, often unequal, radiating ribs, obscurely nodular at intervals, especially towards the margin, often alternately large and small. The anterior ear has many radiating ribs, crossed by concentric lines of growth; the posterior ear has fewer thicker radiating ribs. The right valve is almost smooth, but towards the margin there is evidence of fine radiating ribs.

Dimensions.—Pl. XV, fig. 14, a left valve in the collection of the Geological Survey, Jernyn Street, No. 7256, measures—

Antero-posteriorly	.	.	.	21 mm.
Dorso-ventrally	.	.	.	21 mm.

Localities.—England: the Carboniferous Limestone of Wetton and Narrowdale, Staffordshire. Ireland: the Carboniferous Limestone of Town Plots, Killala.

Observations.—The specimen labelled *Pecten pera* in the Griffith Collection, Museum of Science and Art, Dublin, can hardly be the original type, for it is much larger than the figure. *McCoy* re-described this species and referred to it some shells from the Black Limestone of Derbyshire; but if these be the shells labelled *A. pera* in the Woodwardian Museum, he has confused *A. Knockonniensis*, *McCoy*, with the *Pecten pera* of his previous work.

Remarking on the specimens in the Woodwardian Museum, *McCoy* makes the following curious statement:—"From the greater perfection of the English specimens, I have no doubt a portion of the ventral margin must have been absent in the specimens I originally figured, making the ears appear too large." Only one specimen appears to have been figured. It is thus difficult to determine this species with certainty, owing to the confusion by its author of two descriptions based on different shells, and by the loss of the type. I rely on the original description, and especially on the character of the ears, which *McCoy* states to be

marked "with about ten or twelve sharp radiating striæ similar to those of the body, and crossed by very delicate striæ."

AVICULOPECTEN DECUSSATUS, *McCoy*, sp., 1844. Plate XVIII, figs. 19, 20.

LIMA DECUSSATA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 87, pl. xv, fig. 3.

Cf. — CONCINNA, *McCoy*, 1844. Ibid., p. 87, pl. xv, fig. 6.

Cf. PECTEN TRIPARTITUS, *McCoy*, 1844. Ibid., p. 101, pl. xvi, fig. 8.

Specific Characters.—Shell below medium size, ovate, acute, moderately gibbose. The margin regularly rounded. The hinge-line straight, of moderate length. Umbones small, pointed, subcentral. Ears well defined; the anterior large, depressed, deep, and rectangular; the posterior small and triangular.

Interior.—Unknown.

Exterior.—The surface is ornamented with very close, fine, radiating lines, best seen on the sides in the young, but present all over the lower part of the valve. The ears have the same ornament decussated by concentric lines of growth.

Dimensions.—Pl. XVIII, fig. 19, the type of *Lima decussata*, *McCoy*, measures—

Antero-posteriorly 13 mm.

Dorso-ventrally 16 mm.

Localities.—Ireland: the Carboniferous Limestone of Killymeal, co. Tyrone; Ballinglen, co. Mayo.

Observations.—The types of *L. decussata*, *L. concinna*, and *Pecten tripartitus* are all present in the Griffith Collection, Museum of Science and Art, Dublin. The first shell is puzzling, for while it is a left valve, incomplete on the posterior edge of the valve, the figure shows a whole shell; but the description, on the other hand, reads—"Obliquely ovate, . . . ears very small, equal; hinge-line oblique; surface radiated with numerous, unequal, obtuse, smooth ridges; the spaces between each are strongly striated transversely." The figure and type are not oblique, have each unequal, rather large ears, a straight horizontal hinge-line, and I cannot detect any transverse striations. I think, therefore, *McCoy's* description must be disregarded, and as figure and specimen agree fairly well, it may be assumed to be the original type.

I think it probable that *L. concinna*, *McCoy*, was a juvenile form of the same species, but I have no doubt that *P. tripartitus*, *McCoy*, is a very young example of *A. decussatus*, and that the peculiar arrangement of the radiating lines, supposed to be typical of *P. tripartitus*, is either accidental or due to an early condition of growth.

AVICULOPECTEN LOSSENI, von Koenen, sp., 1879. Plate XVIII, figs. 1, 2.

PECTEN LOSSENI, von Koenen, 1879. Neues Jahrb. f. Min., p. 328, pl. vi, figs. 1 a—d.

Specific Characters.—Shell of very moderate size, triangularly ovate, almost equilateral. The anterior and posterior borders very oblique and nearly straight, the inferior border broadly rounded. The hinge-line short. The ears triangular, well marked off from the valve, produced and pointed along the upper border, the margins falcate; the posterior larger than the anterior ear. The umbones small, pointed, and incurved.

Interior.—Unknown.

Exterior.—The right valve is marked with concentric lines and striæ of growth; the ears possessing few but well-marked radiating ribs, decussated by concentric lines of growth. The left valve is ornamented with numerous close, fine, distinct, radiating ribs, new ones arising between each original pair as they pass over the shell. The ribs are crossed by fine concentric lines and striæ of growth. Ears with radiating ribs, fewer and wider apart in the posterior ear.

Dimensions.—Pl. XVIII, fig. 1, a crushed specimen from Angram Brook, measures—

Antero-posteriorly	.	.	.	.	27 mm.
Dorso-ventrally	.	.	.	.	27 mm.

This would be probably much narrower in a normally gibbose specimen.

Localities.—The Pendleside series of Angram Brook, Pendle Hill, Lancashire.

Observations.—Unfortunately all my examples of this species are crushed flat in a shaly matrix, but I have no hesitation in referring them to *A. Losseui* of von Koenen, who gives excellent figures of this species.

I have been able to make out that the right valve has no radiating ribs, for in two specimens the valves have been crushed on each other.

Von Koenen refers *P. lineatus*, Sarres, to his species, which he considers to be distinct from *P. lineatus*, Goldfuss. I have no knowledge of the original shells of these authors, and am therefore unable to advance any opinion on the question of the synonymy of the species.

I think the species should be placed in the genus *Aviculopecten*, to the other species of which it has a general resemblance.

A. Losseui is another shell common to the Pendleside series of England and the Culm of the European continent.

AVICULOPECTEN INTERMEDIUS, *McCoy*, sp., 1844. Plate XV, figs. 19, 20, 24, 25.

PTERINEA INTERMEDIA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 82, pl. xiii, fig. 1.

Specific Characters.—Shell small, triangularly gibbose, very slightly oblique posteriorly; right valve unknown. The hinge-line long, produced posteriorly along the pointed ear. The umbones narrow, gibbose, pointed, and placed a little in front of the centre. The ears well formed and depressed, comparatively large, the posterior much larger and deeper than the anterior ear; the upper border of the posterior ear prolonged and pointed, its posterior margin markedly falcate.

Interior.—Unknown.

Exterior.—The left valve is ornamented with many fine, close, angular, radiating ribs, which become larger and farther apart as they cross the valve; and secondary fine angular ribs arise between each primary pair. Towards the lower margin the ribs are crenulate. The posterior ear has a few distant, obsolete, radiating lines, crossed by concentric lines. The anterior ear has also almost obsolete radiating ribs.

Dimensions.—A small specimen from Hill Bolton, Yorkshire, in my collection, measures—

Antero-posteriorly	11 mm.
Dorso-ventrally	12 mm.
Gibbosity of valve	2.5 mm.

Localities.—England: the Carboniferous Limestone of Settle and Hill Bolton, Yorkshire; Castleton, Derbyshire; and Poolvash, Isle of Man. Ireland: no locality is given for this shell in Griffith's list of localities ('Journ. Geol. Soc. Dub.,' vol. ix, p. 106).

Observations.—This species was referred by McCoy to *Pterinea*, but the long posterior ear and the well-marked anterior ear show its affinities to be rather with *Aviculopecten* than with that genus. I have been able to examine about half a dozen specimens, one of which, from Settle, is in the Woodwardian Museum. This (Pl. XV, fig. 24) shows the posterior ear very well. Pl. XV, fig. 19, represents the left valve of a much younger shell, but unfortunately lacks the prolonged portion of the posterior ear.

The type specimen is not in the Griffith Collection at the Museum of Science and Art, Dublin. McCoy's description and figure, however, are sufficiently distinctive and full, and there is no difficulty in recognising the peculiar characters of the species.

The ribs in older shells are coarse, irregular, and tend to be compound and to lose the crenulate marking of the younger stages.

AVICULOPECTEN CLATHRATUS, *McCoy*, sp., 1844. Plate XV, figs. 1—7.

PECTEN CLATHRATUS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 90, pl. xiv, fig. 12.

— INTERCOSTATUS, *McCoy*, 1844. Ibid., p. 95, pl. xviii, fig. 4.

Specific Characters.—Shell of medium size, slightly oblique, transverse, triangularly fan-shaped, moderately gibbose, and very inequivalve, the right being almost as flat as the left valve. The ears, especially the anterior, small and depressed. The hinge-line short and straight. The lower margin broadly convex, and the anterior and posterior margins almost straight, inclined obliquely inwards and upwards to the base of the ears. The umbo in the left valve small, pointed, swollen, and incurved, subcentral, that in the right valve almost obsolete.

Interior.—Unknown.

Exterior.—The left valve is ornamented with from fifteen to eighteen strong radiating ribs, and between each pair are three other finer ribs, of which the centre is the stronger and extends further towards the umbo. It may happen these secondary strong ribs become so well marked that the valve appears to have alternate strong and weak ribs. The valve is also crossed by close concentric lines, which are best marked in the spaces between the ribs and on the surface of the finer ribs. The ears have radiating ribs and concentric striae. The right valve is smooth both on the body and on the ears.

Dimensions.—Pl. XV, fig. 1, a specimen in the collection of Mr. Joseph Wright, measures—

Antero-posteriorly	.	.	.	.	27 mm.
Dorso-ventrally	.	.	.	.	23 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire; Narrowdale, Staffordshire; Settle, Yorkshire. Ireland: the Carboniferous Limestone of Little Island and Ballydaniel, co. Cork; Drunkeeran, co. Fermanagh.

Observations.—This species was founded on the peculiar ornament of a left valve. The right valve proves to be quite smooth, as is indicated by a very young bivalved example in Mr. Joseph Wright's collection, from Little Island, co. Cork (Pl. XV, fig. 4). The peculiar marking described by McCoy is only well developed in the full-grown shell. As the primary ribs, starting from the umbo, pass across the valve, one new rib arises between each pair, and some little way further on another rib becomes developed between each primary and secondary. If the secondary ribs are well developed there is a condition of alternate large and small ribs, the normal condition near the umbo; but occasionally all three sets of ribs remain a different size, which is the condition described by McCoy.

I think it possible that *Pecten orbiculatus*, a species founded on a right valve, may belong to the species under discussion, judging from the likeness of that figure to the right valve of *A. clathratus*.

P. intercostatus, M'Coy, is a left valve of *A. clathratus*. The type is still preserved in the Griffith Collection, Museum of Science and Art, Dublin, where I have examined it; but I cannot see the spines on the ribs which M'Coy regarded typical of the species. They may have been there, and M'Coy states that "this beautiful little shell appears very closely allied to *P. interstitialis*, Phill., but the number of small ribs between every two large ones, instead of being regularly three, is seldom less than five, and as frequently nine on the one specimen. . . . It is seldom that any of the delicate spines are preserved, the ribs more frequently presenting a roughened or tuberculated aspect." In the figured specimen (Pl. XV, fig. 7) there appears to be three fine ribs between each pair of larger ones, and not, as M'Coy states, five or nine.

AVICULOPECTEN FORBESII, M'Coy, sp., 1844. Plate XVIII, figs. 3—7.

PECTEN FORBESII, M'Coy, 1844. Synops. Carb. Foss. Ireland, p. 93, pl. xv, fig. 20.

AVICULOPECTEN FORBESII, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 223, pl. xxxv, figs. 14, 15.

Specific Characters.—Shell small, suborbicular, slightly convex, the right valve a little less so than the left valve. The margin fairly regularly rounded from ear to ear. The hinge-line straight and comparatively long. Umbones small, pointed, subcentral. The ears small, triangular; the right anterior ear deeply slit for the byssus; the posterior ears larger than the anterior, the upper border prolonged and pointed, posterior margin falcate.

Interior.—Unknown.

Exterior.—The surface is ornamented with strong radiating ribs, alternately larger and smaller, the latter not starting at the umbo. The ribs are cancellated by distant concentric ridges. The ears have a somewhat similar ornament.

Dimensions.—Pl. XVIII, fig. 7, a right valve, the type of *Pecten Forbesii*, M'Coy, measures

Antero-posteriorly	10 mm.
Dorso-ventrally	9.5 mm.

Localities.—Ireland: the Carboniferous Limestone of Millicent, co. Kildare; Little Island, co. Cork. Scotland: Curriecree Quarry, Tynewater.

Observations.—This species was founded on a right valve, which is in the Griffith Collection, Museum of Science and Art, Dublin. Curiously enough, the

figure of this specimen seems to be the only one which was reversed on the stone and consequently shows correctly on the plate. This does not excuse the author of the description of the species in de Koninck's work for the statement that "the right valve is unknown." Mr. J. Wright has a series of four specimens in his collection from Little Island, co. Cork, two of which are right and two left valves.

Pecten Hardingii, McCoy, judging from the figure, is probably the same species, but the type has disappeared, and it is impossible to say what the original may have been.

AVICULOPECTEN MACROTIS, McCoy, sp., 1844. Plate XVIII, figs. 15—18.

PECTEN MACROTIS, McCoy, 1844. Synops. Carb. Foss. Ireland, p. 96, pl. xvi, fig. 13.

Specific Characters.—Shell small, only moderately convex, transverse diameter rather large compared with the size of the shell. The anterior border short, descending obliquely downward and forward; the lower border broad and convex; the posterior border descending obliquely from the umbo backwards and downwards and nearly straight. The hinge-line long and produced above the upper border of each ear. The umbones small and pointed. The ears large, well defined, and depressed, with the margins of both falcate.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous fine ribs. The ears are almost smooth, but have delicate concentric lines of growth.

Dimensions.—Pl. XVIII, fig. 16, measures—

Antero-posteriorly	.	.	.	17 mm.
Dorso-ventrally	.	.	.	13 mm.

Localities.—Ireland: the Carboniferous Limestone of Little Island, co. Cork; Bruckless, Dunkineely, co. Donegal.

Observations.—It is uncertain whether this species is not the very young stage of *A. fallax*. I have found six specimens in the cabinet of Mr. J. Wright which appear to be about the size of the type (Pl. XVIII, fig. 18). The type is preserved in the Griffith Collection, Museum of Science and Art, Dublin, and is a right valve.

AVICULOPECTEN KNOCKONNIENSIS, McCoy, sp., 1844. Plate XIV, figs. 8—13.

PECTEN KNOCKONNIENSIS, McCoy, 1844. Synops. Carb. Foss. Ireland, p. 95, pl. xvii, fig. 4.

Cf. — BELLIS, McCoy, 1844. Ibid., p. 89, pl. xv, fig. 15.

AVICULOPECTEN PERA, McCoy, 1855. Brit. Pal. Foss., p. 488.

Specific Characters.—Shell small, longitudinally ovate, moderately convex; ears comparatively large; both valves with somewhat similar ornament, the right flat, the left convex. The anterior margin of the left valve and the posterior margins of both somewhat falcate. The anterior margin of the right valve deeply slit for the byssus below the ear. The lower margin rounded. The hinge-line comparatively short, produced along each ear and pointed. The umbones small, triangular, and pointed, almost central. The anterior ear of right valve large, its margin rounded, separated from the rest of the valve by a hollow sulcus; that of the left valve triangular and well defined. The posterior ears comparatively large, well defined, the posterior border falcate.

Interior.—Unknown.

Exterior.—The surface is ornamented with numerous radiating ribs, closely set with imbricating scales; and between each pair smaller ones arise, with here and there certain ribs stronger than others. These ribs are crossed occasionally by concentric lines of growth. The posterior ears and left anterior ear are crossed by numerous radiating ribs; the right anterior ear is crossed by three strong ribs, but has concentric lines of growth strongly marked.

Dimensions.—Pl. XIV, fig. 11, a left valve, measures—

Antero-posteriorly	30 mm.
Dorso-ventrally	28 mm.

Localities.—England: Black Limestone of Derbyshire; above the Underset Limestone, Farcote Gill, Westmoreland. Scotland: Carboniferous Limestone series of West Quarry, Salton; Cateraig Sea Quarry, Dumbar; Carrieelee Quarry, Tynewater. Ireland: Arenaceous Limestone of Knockonny, Ballygawley, co. Tyrone.

Observations.—McCoy's types are probably preserved in the Griffith Collection, Museum of Science and Art, Dublin, where I have been permitted to examine them. The specimens are not good and have been crushed, but still the characters of the species are fairly definite and can be recognised. McCoy's account is somewhat confusing:—"Valves dissimilar, the one marked with close, fine, smooth, radiating striae, slightly flexuous, and nearly equal in size; the other radiated with about twelve larger, rounded ribs, each having a very fine sharp ridge on each side, each set of ribs being separated from the rest by a narrow flat space; all the radiating ridges on this valve are closely set with small, imbricating, scale-like laminae of growth." He does not say which valve has the special ornament mentioned. There are three specimens in the collection, and neither on them nor in the figure can I distinguish the ornament described above. The fact is that, as in most of the species of this size, there is much irregularity in the growth and size of individual ribs, and in the majority of ribbed Pectiniform shells the large or primary rib, which starts from the umbo, is associated with a narrow secondary rib on each side.

Several specimens from localities in East Lothian are in the collection of the Geological Survey of Scotland, and among these are some with fewer and rather coarser ribs. The left valve of *A. gentilis*, Sow., sp., may be mistaken for *A. Knockonniensis*, but the former shell has a smooth right valve.

I consider *P. bellis*, McCoy, to represent a young uncrushed example of the species under discussion. The shape of the ears and general similarity of the valve are very striking.

AVICULOPECTEN GENTILIS, *J. de C. Sowerby*, sp., 1840. Plate XVII, figs. 6—10.

PECTEN GENTILIS, *J. de C. Sowerby*, 1840. In Prestwich's Geol. Coalbrookdale, Trans. Geol. Soc., ser. 2, vol. v, pl. xxxix, fig. 19.

— SCALARIS, *J. de C. Sowerby*, 1840. Ibid., pl. xxxix, fig. 20.

AVICULOPECTEN FIBRILLOSUS, *Hind*, 1902. Trans. N. Staffs. Field Club, vol. xxxvi, p. 80, pl. ii, figs. 4, 5.

Specific Characters.—Shell small, the left valve convex, the right much less so, obliquely ovate. The anterior margin short and convex; the lower expanded and rounded; the posterior almost straight and oblique. The hinge-line medium size. Umbones small, subcentral. Ears depressed, well defined from the shell both in front and behind, the posterior prolonged and somewhat pointed.

Interior.—Unknown.

Exterior.—The right valve is smooth, with very fine microscopic concentric lines, the ears with several radiating ribs, fewer and coarser on the anterior ear, both crossed by fine concentric lines. The left valve is ornamented with numerous fine raised ribs, between each pair of which soon arises a secondary rib. Occasionally very fine concentric lines of growth are to be found. Both ears are ornamented in a similar manner. The ribs on the anterior ear fewer and coarser than on the right ear.

Dimensions.—Pl. XVII, fig. 9, a specimen from Congleton Edge, Cheshire, measures

Antero-posteriorly	.	.	.	.	15 mm.
Dorso-ventrally	.	.	.	.	14 mm.

Localities.—Pennystone Ironstone, Coalbrookdale; below Third Grit, Congleton Edge, Cheshire; below Third Grit, Eccup, Leeds.

Observations.—The figure of *J. de C. Sowerby's Pecten gentilis* in Prestwich's memoir above cited is very well drawn, and shows the peculiar form of the left valve very well. No mention is made of the right valve. A shell, said to be the type, is in the collection obtained from the late Sir Joseph Prestwich at the

Natural History Museum, but this can hardly have served for the figure, as the ears are not well developed from the matrix, the anterior not being at all visible.

Two other figures of a Pectiniform shell are given in the same work as *P. scalaris*. These I consider to represent the same species as the former shell, the only apparent difference in the figures being the number of ribs; but the descriptions of both shells state that the number is fifteen in each case.

In 1902 (*loc. cit.*) I figured both valves of a little shell from a richly fossiliferous bed on Congleton Edge, about 500 feet below the Third Millstone Grit, as Salter's species, *A. fibrillosus*. Right and left valves occur close behind each other on the same slab; but I am convinced that my shells are identical with *A. gentilis*, and that I was wrong to trust to the published figure of Salter's species, from which it is quite distinct, as may be seen on reference to the figures of *Pseudamysium fibrillosum* now given (Pl. XVI, figs. 16—22).

AVICULOPECTEN PERRADIATUS, *de Koninck*, 1885. Plate XV, figs. 16—18.

AVICULOPECTEN PERRADIATUS, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 229, pl. xxxiv, figs. 12, 13.

Specific Characters.—Shell small, suborbicular, left valve very gently convex. The margin of the valve almost circular from ear to ear. The hinge-line straight. Umbones small, pointed, subcentral. Ears well defined; the left anterior ear triangular, narrow, and small, well marked off from the valve by a groove, its anterior margin gently rounded; the left posterior ear longer and deeper, and larger than the anterior, pointed, its posterior margin falcate. A shallow oblique depression in the valve both in front and behind just below the folds for dividing off each ear.

Interior.—Unknown.

Exterior.—The surface of the left valve is ornamented with numerous, fine, unequal, radiating ribs, secondary ribs arising between each primary pair. The ribs are traversed by four concentric lines of growth and are finely reticulate. Both ears are crossed by several radiating ribs decussated by lines of growth.

Dimensions.—Pl. XV, fig. 17, a specimen in the collection of the Geological Survey Museum, Jermyn Street, from Narrowdale, measures—

Antero-posteriorly	.	.	.	.	17 mm.
Dorso-ventrally	.	.	.	.	16 mm.

Localities.—The Carboniferous Limestone of Narrowdale, Staffordshire, and Park Hill, Derbyshire.

Observations.—This species was founded by de Koninck on a specimen from the Limestone of Visé, and his description is very full and accurate, with a good

figure. The right valve is stated by him to be unknown, and I have not been able to identify it. The small ears and circular shape, with the numerous radiating ribs, are characters which serve to distinguish the species.

AVICULOPECTEN STELLARIS, *Phillips*, sp., 1836. Plate XVI, figs. 7—11.

PECTEN STELLARIS, *Phillips*, 1836. Geol. Yorks., vol. ii, p. 212, pl. vi, fig. 18.

— VILLANUS, *de Koninck*, 1851. Descr. Anim. Foss. Belg., App., p. 684, pl. lvii, fig. 4.

AVICULOPECTEN VILLANUS, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 218, pl. xxxiii, figs. 7, 8; pl. xxxiv, fig. 22.

— INGRATUS, *de Koninck*, 1885. Ibid., p. 224, pl. xxxv, figs. 33, 34.

Specific Characters.—Shell below medium size, quadrato-orbicular, the left valve moderately gibbose, the right less so. The margin of the valve from ear to ear regularly curved, almost circular. The hinge-line long, rolled, extending almost as far forward as the anterior margin, and posteriorly somewhat beyond the posterior margin. The umbo central as regards the body of the valve, gibbose and pointed in the left valve, and not elevated. Anterior ears depressed, deeply marked off from the rest of the valve by an angular groove; the posterior ears long and gradually compressed, falcate.

Interior.—Unknown.

Exterior.—The convex surface of the left valve is adorned with simple, rounded, radiating ribs, which may or may not have secondary ribs arising between each pair as they approach the margin. The ribs are quite absent on the ears, which are only concentrically striated by fine lines of growth. The body of the valve is crossed by very fine concentric striæ, one of which is sometimes fairly deep, making the ribs along this line imbricated. The sulci between the ribs are very finely striated concentrically.

Dimensions.—Pl. XVI, fig. 8, a left valve from Castleton, measures—

Antero-posteriorly	.	.	.	25 mm.
Dorso-ventrally	.	.	.	25 mm.
Length of hinge-line	.	.	.	27 mm.
Convexity of valve	.	.	.	7 mm.

Localities.—England: the Carboniferous Limestone of Castleton and Park Hill, Derbyshire; Hill Bolton and Settle, Yorkshire; above Main Limestone, Nine Standards Rigg, Westmoreland; the White Limestone, Poolvash, Isle of Man. Ireland: the Carboniferous Limestone of Little Island, co. Cork.

Observations.—The type of *Pecten stellaris*, *Phillips*, is preserved in the Gilbertson Collection, Natural History Museum, South Kensington. It is a left

valve (Pl. XVI, fig. 7), with the posterior ear broken off and the anterior ear only half developed, but shows well the bold character of the radiating ribs. It will be noticed, on examining the specimen, that the secondary ribs are few, and commence low down on the valve. This I regard as an abnormality, due probably to insufficient nourishment or want of carbonate of lime. It is owing to this fact, probably, that de Koninck and McCoy described this species under other names.

Aviculopecten villanus, de Kon., has the peculiar circular-shaped valve, the large ears, and long hinge-line pointed at each end, and simply varies from Phillips's shell in that the secondary ribs start regularly high up, not far from the beak, and rapidly become equal in size to the primary ones. De Koninck figures the right and left valves. He points out that the former has more numerous and finer radiating ribs, and is flatter than the left valve.

AVICULOPECTEN INCRASSATUS, McCoy, sp., 1844. Plate XVI, figs. 12—15.

PECTEN INCRASSATUS, McCoy, 1844. Synops. Carb. Foss. Ireland, p. 94, pl. xvi, fig. 1.

AVICULOPECTEN ILLEGALIS, McCoy, 1855. Brit. Pal. Foss., p. 486.

— MEGALOTIS, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 230, pl. xxxvi, fig. 25.

Specific Characters.—Shell below medium size, inequivalve, suborbiculary quadrate, the left valve regularly and moderately convex, the right valve less so. The curvature of the margin from ear to ear oblate. The hinge-line straight and prolonged specially backwards, rolled. The umbones subcentral, that of the left valve moderately convex, pointed, very slightly raised; the right much less pronounced, triangular, and pointed. The anterior ears depressed, separated from the body of the valve by an oblique sulcus, more linear and acute in the right valve. The anterior margin of this ear rounded. The posterior ears long, pointed, falcate, formed by a gradual compression of the valve.

Interior.—Unknown.

Exterior.—The surface of the valve is adorned with many thick radiating ribs, between each pair of which a secondary rib arises, about halfway across the valve or sooner. The ears are almost smooth, the posterior marked with faint concentric lines and striæ, but no radiating ribs. The right valve is very similar to the left valve.

Dimensions.—Pl. XVI, fig. 15, the type, measures—

Antero-posteriorly	.	.	.	:	33 mm.
Dorso-ventrally	.	.	.	.	31 mm.

Localities.—England: the Carboniferous Limestone of Settle and Malham

Moor, Yorkshire; Castleton, Derbyshire. Ireland: the Carboniferous Limestone of Little Island and Cork, co. Cork; Lisnapaste, Ballintra, co. Donegal.

Observations.—The type of *P. incrassatus*, M'Coy, is preserved in the Griffith Collection, Museum of Science and Art, Dublin, and is a fine example of the left valve of a full-grown shell (Pl. XVI, fig. 15). This species belongs to a group with large ears, which are almost smooth, and have no radiating ridges. The right valve is flatter than the left valve, but has an almost identical ornament, the right anterior ear being divided from the valve by a slit for the byssus.

M'Coy unknowingly described this species under two names, for in 1855 he referred specimens in the Woodwardian Museum to *P. illegalis*, de Koninck, while assigning *Pecten plicatus*, of Phillips *nec* Sowerby, to this species. De Koninck had made the same mistake in 1842; but he termed the shell *Pecten Phillipsianus*, subsequently corrected to *P. illegalis*, neither of which names is mentioned in his later work.

It seems to me that the species is most frequently found in collections named *A. megalotis*, M'Coy. The latter species was founded on a small fragment, showing the posterior ear and a small portion of the adjacent part of the valve. Its ribs were not nearly as coarse as those of *A. incrassatus*, and in my opinion the shell was much too fragmentary for the foundation of a species. A second figure was given, but this is not from any shell in the collection, and was probably a restoration. At any rate, the name *P. incrassatus* appears in M'Coy's work before that of *P. megalotis*, and therefore has the right of priority.

AVICULOPECTEN NOBILIS, *de Koninck*, sp., 1842. Plate XVI, figs. 1—6.

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| PECTEN NOBILIS, <i>de Koninck</i> , 1842. | Descr. Anim. Foss. Belg., p. 132, pl. iii, fig. 24. |
| -- CANCELLATUS, <i>M'Coy</i> , 1844. | Synops. Carb. Foss. Ireland, p. 89, pl. xiv, fig. 9. |
| - ÆQUALIS, <i>M'Coy</i> , 1844. | Ibid., p. 89, pl. xv, fig. 13. |
| — COGNATUS, <i>M'Coy</i> , 1844. | Ibid., p. 90, pl. xix, fig. 4. |
| AVICULOPECTEN CANCELLATUS, <i>M'Coy</i> , 1855. | Brit. Pal. Foss., p. 483, pl. 3 E, fig. 3. |
| — NOBILIS, <i>de Koninck</i> , 1885. | Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 217, pl. xxxvi, figs. 27, 28, 30. |

Specific Characters.—Shell small, triangularly suborbicular, inequilateral, the left valve slightly more convex than the right valve. The margin of the valve regularly rounded. The hinge-line straight, prolonged only slightly backwards. The anterior ears moderately large, depressed, well marked off from the body of the valve, the anterior margin falcate; the posterior ears gently compressed and expanded, also falcate. The umbones triangular, pointed and swollen, slightly raised, subcentral.

Interior.—Unknown.

Exterior.—The surface is ornamented with 15 to 20 radiating ribs, not always of equal strength, crossed at regular intervals by about 13 concentric ribs, dividing the surface into distinct quadrilateral spaces. The ears marked by imbricating, concentric lines. In the right valve the concentric ribs are less well marked and are often obsolete.

Dimensions.—Pl. XVI, fig. 1, measures—

Antero-posteriorly	19 mm.
Dorso-ventrally	17 mm.
Convexity of left valve	2 mm.

Localities.—England: the Carboniferous Limestone of Settle, Yorkshire; Castleton, Derbyshire; Lowick, Northumberland. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Killymeal, Dungannon, co. Tyrone.

Observations.—De Koninck's species, *Pecten nobilis*, has the right of priority over M'Coy's *P. cognatus*, which de Koninck recognised as a synonym of his shell. At first glance this species might be mistaken for *Pterinopecten tessellatus*, Phill., sp., but the latter is much broader, has no distinct posterior ear, and obviously fewer concentric lines and ribs. The two species are therefore generically distinct.

Specimens of *A. nobilis* vary considerably as to the number and strength of the radiating and concentric ribs. I am not at all sure that *Aviculopecten Forbesii* of de Koninck belongs to the species under discussion.

A. cancellatulus, M'Coy, is the young form of de Koninck's species. The Woodwardian Museum, Cambridge, possesses a fine series from Settle, showing both right and left valves in various stages of growth. The confusion of the various species now referred to *A. nobilis* has doubtless arisen from the varying characters of the ornament due to the strength, number, and degree of development of the radiating ribs and concentric ridges. M'Coy states that *A. cancellatulus* is distinguished from all other species "by the very large spherical or conoidal nodules at the intersection of the concentric and radiating ridges." I have noted this character in *A. nobilis*, especially in the younger part of the valves. I think that *P. æqualis*, M'Coy, the type of which is a very poor specimen, is only the young of *A. nobilis*. The types of both *P. æqualis*, M'Coy, and *P. cancellatulus*, M'Coy, are from the same locality and horizon, Killymeal, Dungannon.

AVICULOPECTEN PLANOCLATHRATUS, M'Coy, sp., 1844. Plate XV, figs. 8—12.

PECTEN PLANOCLATHRATUS, M'Coy, 1844. Synops. Carb. Foss. Ireland, p. 98, pl. xvi, fig. 2.

Cf. AVICULOPECTEN TENUILINEATUS, de Koninck, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 224, pl. xxxv, fig. 31.

Specific Characters.—Shell small, oblique anteriorly, ovate, acute, the left valve convex, the right less so. The margin rounded, the curvature starting at a lower point in front than behind owing to the larger size of the anterior ear, which is much and rapidly depressed from the body of the valve. The hinge-line straight, of moderate length. The umbones triangular, pointed, convex, central. The anterior ear of the right valve separated from the rest of the shell by a slit for the byssus. The posterior ear small, rapidly compressed, and triangular.

Interior.—Unknown.

Exterior.—The left valve is ornamented by close concentric lines and radiating ribs of almost the same strength, giving a fine reticulated appearance. The ears seem to possess somewhat the same character, only less well marked. The ornament of the right valve is not essentially different from that of the left valve.

Dimensions.—Pl. XV, fig. 11, measures—

Antero-posteriorly	.	.	.	15.0 mm.
Dorso-ventrally	.	.	.	15.0 mm.
Convexity of left valve	.	.	.	2.5 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire; Poolvash, Isle of Man. Scotland: Buriebrae Burn, near Milton of Campsie; Annick Water, near Stewarton. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Bundoran, co. Donegal.

Observations.—This species was founded on a single imperfect example from which the ears were wanting, and it is impossible to say which valve it is. The type is preserved in the Griffith Collection, Museum of Science and Art, Dublin. The cabinet of Mr. Joseph Wright contains six good examples of *A. planoclathratus* from the Limestone of Little Island, co. Cork, four of which are right and three left valves. The anterior ears are well preserved in all the specimens, but the posterior are lost. The characters of the shell are very marked, and I have no hesitation in retaining the species.

I think it possible that *Ariculopecten tenuilineatus*, de Koninck, may represent *A. planoclathratus*. Its antero-posterior and dorso-ventral diameters are the same, and its ornament is similar; but the specimen figured is much larger than any I have yet seen. In the enlarged view of the surface the concentric lines are shown to be less strongly marked than the radiating ribs. I am unable to see by what essential characters *A. tenuilineatus* is distinguished from *A. perplicatus*, de Koninck, the latter being only a larger shell.

AVICULOPECTEN QUINQUELINEATUS, *McCoy*, sp., 1844.

PECTEN QUINQUELINEATUS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 98, pl. xvii, fig. 6.

Specific Characters.—Shell large, orbicular, right valve only slightly convex. The lower margin almost circularly rounded. Ears and hinge-line unknown.

Interior.—A large posterior adductor scar in the normal position.

Exterior.—The surface is ornamented with many narrow, uneven, radiating ridges, between each pair usually fine, smaller, radiating striæ, the middle one of which is largest; interstitial spaces flat.

Locality.—Ireland: the Carboniferous Limestone of Mohill, co. Leitrim.

Dimensions.—Too imperfect to measure.

Observations.—The species was founded on a fragment of a left valve, the ears and upper part of which were absent. The type is present in the Griffith Collection, Museum of Science and Art, Dublin; hence I have retained the species. The ornamentation is very like that of *A. interstitialis* in the adult form, but the fragment is much too flat for this species. Possibly a specimen will some day be found showing the real affinity of this shell and its value as a species. It is to be noted that *McCoy's* figure shows three smaller radiating ribs between each pair of large ones, not, as he states, five.

AVICULOPECTEN FIMBRIATUS, *Phillips*, sp., 1836. Plate XII, figs. 12, 13.

PECTEN FIMBRIATUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 213, pl. vi, fig. 28.

Specific Characters.—Shell of medium size, both valves very moderately convex, the right very little the less so, ovato-orbicular. The hinge-line short and straight. The umbones central, pointed, moderately swollen. The anterior ears short, depressed, well marked off from the rest of the valve, with a slit below the right anterior ear for the byssus. The posterior ears small, depressed, well defined, the sharp margin from the umbo to the anterior border somewhat concave upwards.

Interior.—Smooth. The decorticated shell shows many radiating and concentric ribs.

Exterior.—The surface is ornamented with many sinuously imbricate, concentric ridges, and similar radiating ribs, which give rise to a cancellated appearance in the right valve, the concentric markings being less rugose and somewhat more regular. The ears appear to be almost smooth.

Dimensions.—Pl. XII, fig. 13, a right valve from Settle, in the York Museum, measures—

Antero-posteriorly	.	.	53 mm. estimated.
Dorso-ventrally	.	.	53 mm.

A bivalved example of almost the same size measures 18 mm. from side to side.

Localities.—England: the Carboniferous Limestone of Settle, Yorkshire; Castleton, Derbyshire; Narrowdale and Wetton, Staffordshire.

Observations.—The type of *Pecten fimbriatus*, Phillips, is unfortunately missing, but the figure is good, and the description, though meagre, is sufficiently detailed for the identification of the species. The original description is as follows:—"Oblong, depressed, with small plain ears; surface radiated with obtuse ribs and furrows, all sinuoso-imbricate." Apparently a left valve was figured. The right valve differs very little, both in convexity and ornament, from the left valve. Pl. XII, fig. 12, represents a semi-decorticated specimen of a bivalved example. A small patch of the outer shell remains on the left valve. The specimen is figured to show how easily a shell in this condition might be referred to an entirely different species.

The ornament on the right valve of *A. dissimilis*, Flem., sp., resembles somewhat that of *A. fimbriatus*, but the shape of the valve and the ears are quite different. The locality given for the type specimen is Castleton, probably Derbyshire.

A fine right valve in the York Museum is figured (Pl. XII, fig. 13), and this is almost entire, only the anterior ear being wanting.

AVICULOPECTEN INTERSTITIALIS, *Phillips*, sp., 1836. Plate XIV, figs. 16—21.

PECTEN INTERSTITIALIS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 24.

— SEGREGATUS, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 99, pl. xvii, fig. 3.

— KOKCHAROFI, *de Verneuil*, 1845. Géol. Russie de l'Europe, p. 325, pl. xx, fig. 16.

— BOUEI, *de Verneuil*, 1845. Ibid., p. 326, pl. xxi, fig. 6.

AVICULOPECTEN SEGREGATUS, *M'Coy*, 1855. Brit. Pal. Foss., p. 489, pl. 3 E, fig. 1.

LIMATULINA SELECTA, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 244, pl. xxxvi, figs. 1—5.

NON AVICULOPECTEN INTERSTITIALIS, *de Koninck*, 1885. Ibid., p. 227, pl. xxxiii, fig. 21.

— BOUEI, *de Koninck*, 1885. Ibid., p. 220, pl. xxxv, figs. 8, 9.

Specific Characters.—Shell below medium size, longitudinally and obliquely subtrigonal, with sharply defined, depressed ears; the left valve gibbose, the right

slightly convex. The hinge-line straight and elongate. The umbones swollen and pointed, subcentral. The anterior ear in the left valve triangular, its anterior superior angle produced, marked off by an angular groove from the valve; the posterior ear falcate.

Interior.—The surface is smooth, showing radiating grooves corresponding with the strong external ridges. Adductor scar shallow, round, and placed high up in the valve, just posterior to the middle line.

Exterior.—The surface of the left valve is marked with about six strong, rugged, radiating ridges, between each pair of which are three or more finer radiating lines, which become more apparent as the lower border of the valve is approached. The centre ridge may reach the umbo. There are obscure concentric folds. The anterior ear has a few obscure radiating folds, but the concentric striae are well marked. The posterior ear is marked by concentric lines of growth parallel with the contour of the ear. The right valve is ornamented with numerous close, equal, rounded, radiating ribs, which bifurcate as they pass across the valve.

Dimensions.—Pl. XIV, fig. 16, measures—

Antero-posteriorly	.	.	.	35 mm.
Dorso-ventrally	.	.	.	32 mm.
From valve to valve	.	.	.	15 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire; Wetton, Staffordshire; Hill Bolton and Settle, Yorkshire; Lowick, Northumberland; Underset Limestone, Farcote Gill and Goodham Gill, Swarth Fell, Westmoreland; Poolvash, Isle of Man. Scotland: the Upper Limestone series of Garngad Road, Glasgow, and Bowertrapping, Shield; New Cunnock, Ayrshire; Lennox Burn Quarry, Haddingtonshire; shore east of Dalskelly Craig, Boglehill, Longniddry; Smallburn, Kilsyth. Ireland: the Carboniferous Limestone of Manor Hamilton, co. Leitrim; Cornfield, co. Clare; Clogherbrian, co. Kerry.

Observations.—*A. interstitialis* has been established on the peculiar characters of the left valve. Phillips only describes this valve, and McCoy, speaking of *A. segregatus*, simply mentions that the right valve is "slightly convex." I have been fortunate enough to obtain one specimen with the valves in contact, and although much weathered, the contour and markings of the right valve are preserved. It occurred in the upper beds of Carboniferous Limestone at Castleton, Derbyshire (Pl. XIV, figs. 16, 17). McCoy's original figure appears as a right valve, but this is an error due to the fact that no allowance was made for the reversal of the figure when drawn on the stone. I quite agree with McCoy that *P. Kokcharoffi*, de Verneuil, is identical with his species, and should therefore be referred to *A. interstitialis*. I also think *Pecten Bouei* of that author is a younger specimen of the same shell. De Koninck has placed *A. segregatus*, McCoy, as a synonym of

de Verneuil's species, showing his view of the matter. *A. interstitialis* has much the same general characters as *A. Murchisoni*; the latter is, however, easily distinguished by possessing a single fine rib between each pair of strong ones in the left valve. M'Coy's very accurate description under the name *A. segregatus* is perhaps a little too exact with regard to the number of strong ribs, and also of the finer ones between them. The number varies with the growth of the valve; in very large examples there may be as many as five secondary ribs in the broadest spaces, which are the fifth and sixth from the anterior end.

I have no hesitation whatever in placing *Limatulina selecta*, de Koninck, as a synonym of M'Coy's shell. De Koninck figures both valves, and describes the peculiar character of the external surface of the right valve.

Although, unfortunately, the type of *Pecten interstitialis* has disappeared, and the figure is quite unrecognisable, yet Phillips's description is sufficiently definite to leave no doubt as to the real character of the shell. The original description is as follows:—"With about sixteen narrow, sharp, rough, radiating ribs, the intervening spaces with three striæ or finer ribs. A specimen in Mr. Gilbertson's collection has stronger ribs. Near the beak the ribs are alternately larger and smaller, ears acute." M'Coy retained Phillips's species, but unfortunately gave no illustrations, in his second account. In his 'Brit. Pal. Foss.,' page 48, however, he evidently describes a different shell. He states that this form possesses nine to eighteen narrow, sharp, radiating ribs, between which are three to nine smaller, and that the ribs have hooked spines at close regular intervals, and he makes *Pecten intercostatus* a synonym of Phillips's *P. interstitialis*. I think M'Coy was in error as to the true characters of Phillips's *P. interstitialis*. In the account of *A. segregatus* M'Coy draws attention to the distribution of the radiating ribs of the left valve as follows:—"Surface radiated with about six strong, narrow, obscurely rugged ridges, between each pair of which are three smaller, the middle one largest and alone extending to the beaks along with the six primary ridges, which they there nearly equal in size." This account is practically identical with that of Phillips. M'Coy's type specimen is so crushed and so faint as to be scarcely recognisable; I do not propose to reproduce it. De Koninck's *Aviculopecten interstitialis* is quite different from Phillips's species; the surface is stated to be "ornamented with radiating ribs, alternately thick and thin." This author draws attention to the fact that M'Coy has quite mistaken the shell; a fragment in the Gilbertson Collection labelled *Pecten interstitialis* should be referred to *A. Murchisoni*, M'Coy. De Koninck thinks it improbable that *P. Kokcharoffi* and *P. Bonoi*, de Verneuil, can be the same species. He considers the former a Permian and the latter a Carboniferous shell. Eichwald, however, who would have had more experience of Russian specimens, and probably access to the types, considered the two species as identical. De Koninck says:—" *P. Kokcharoffi*, de Vern., has a more pronounced shape, and the ribs on

the posterior ear are made rugose by striæ of growth near the junction with the valve, but this portion of the valve in *P. Bouei* is smooth," and he says there is a difference in the number of thin radiating ribs intercalated between the principal ones, but is not more explicit on the matter. I have followed Eichwald, and consider the specific names as synonyms.

AVICULOPECTEN RUTHVENI, *McCoy*, sp., 1851. Plate XIV, fig. 22.

AVICULOPECTEN RUTHVENI, *McCoy*, 1851. Ann. Mag. Nat. Hist., ser. 2, vol. vii, p. 172.

— — — 1855. Brit. Pal. Foss., p. 489, pl. 3 E, fig. 4.

PECTEN GRANOSUS, *Roemer*, 1876. Lithæa Geogn., Atlas, taf. xlv, fig. 4.

AVICULOPECTEN RUTHVENI, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 213, pl. xxxvii, figs. 7, 10, 11; pl. xxxviii, figs. 17, 18.

Specific Characters.—Shell of medium size, suborbicular, moderately convex. Ears large and depressed, hinge-line straight, of moderate length.

Interior.—Unknown.

Exterior.—Surface with about twelve thick, rugged, radiating ribs, between each pair of which are usually three smaller ribs.

Dimensions.—Pl. XIV, fig. 22, the type specimen, measures—

Antero-posteriorly 48 mm.

Dorso-ventrally 55 mm. (estimated).

Locality.—England: the Carboniferous Limestone of Dent, Yorkshire.

Observations.—I am not convinced of the value of *A. Ruthveni* as a species. The type, a left valve in the Woodwardian Museum, is imperfect, the umbones and that region of the shell being lost; but the markings and the large depressed ears make me suspect that the specimen is a large shell of *A. interstitialis*, which has exactly the same ornament and ears.

I would again draw attention to the inaccuracy of *McCoy's* figures. That of *A. Ruthveni* apparently represents a perfect specimen, whereas the whole of the umbonal region and the greater part of the left ear have disappeared.

AVICULOPECTEN CARROLLI, sp. nov. Plate XVII, figs. 24—27.

Specific Characters.—Shell of medium size, obovate, dorso-ventral much greater than the antero-posterior diameter; the left valve convex, the right flattened. The anterior and posterior margins almost straight, but oblique; inferior margin

rounded. The hinge-line straight and comparatively short. The umbones gibbose, pointed, incurved, almost central. The anterior ears larger than the posterior ears, well defined, compressed-triangular, with margin rounded; the posterior ears narrow but deep and compressed.

Interior.—Unknown.

Exterior.—The surface of both valves is ornamented by several unequal, flattened, broad, radiating ribs, the majority of which pass from umbo to margin. Every second or fourth rib is more prominent and larger than the others. The ribs are crossed by fine crenulate lines visible under the microscope, and one specimen shows six radiating colour-bands, the strong ribs dividing the bands and apparently being free from colour. The anterior ear has unequal radiating ribs crossed by concentric striæ of growth.

Dimensions.—Pl. XVII, fig. 26, from Castleton, Derbyshire, measures—

Antero-posteriorly	.	.	.	.	26 mm.
Dorso-ventrally	.	.	.	.	21 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Caherass, co. Limerick; St. Doulaghs, co. Dublin.

Observations.—I have founded this species on several specimens, two from the collection of Mr. Joseph Wright, of Belfast, and three in my own. Mr. Wright has appended the MS. name of *Carrolli* in honour of his friend Mr. Isaac Carroll, the botanist; and I have been glad to adopt it. The species is easily identified by the irregular flattened ribs. It has the same general shape as *A. Murchisoni*. I have, I think, identified correctly as a right valve a specimen in the Geological Survey Collection, Dublin. It has very similar marking to the left valve. The Derbyshire specimen has colour-bands and every fourth rib large, but does not show the crenulations on the ribs, which are present in the Irish examples, and the latter show every second rib to be enlarged. Since writing this description and arranging the plates, some much larger examples have occurred to me from St. Doulaghs.

AVICULOPECTEN MURCHISONI, *McCoy*, sp., 1844. Plate XIV, figs. 3—7.

PECTEN MURCHISONI, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 97, pl. xviii, fig. 3.

— OVATUS, *McCoy*, 1844. Ibid., p. 97, pl. xiv, fig. 11.

AVICULOPECTEN MURCHISONI, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 219, pl. xxxvi, fig. 21.

Specific Characters.—Shell below medium size, triangularly ovate. The left valve convex, the right flattened. The anterior margin almost straight, oblique.

The lower border rounded, its curvature being continued up to the base of the posterior ear. Hinge-line short and straight. Umbones triangular, pointed, central, incurved. Anterior ear much compressed, sharply defined from the valve by a curved groove, the right ear slit for the byssus. Posterior ears small, triangular, depressed, and flattened, also separated from the valve by a deep groove.

Interior.—Unknown.

Exterior.—The left valve is ornamented with from twelve to twenty thick, radiating, nodular, distant ribs, which project as spines below the lower margin of the shell in front; between each pair of ribs is a thin, irregular, moniliform, linear rib. The spaces between the ribs are smooth, but the whole surface of the valve is irregularly nodular. The anterior ear has four or five radiating ridges, the posterior also several. The latter has several spines projecting obliquely backwards and upwards along its upper border. The right valve has numerous close, rounded, radiating ribs, on which are nodular swellings, caused by concentric undulations crossing the ribs. The right anterior ear has about six distant, nodulose, radiating ribs, the intervals between them showing close concentric lines.

Dimensions.—Pl. XIV, fig. 3, the type, measures—

Antero-posteriorly	35 mm.
Dorso-ventrally	40 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire; Poolvash, Isle of Man. Ireland: the Carboniferous Limestone of Little Island and Black Rock, co. Cork; Tankardstown and Ardshanbally, co. Limerick.

Observations.—The type of McCoy's *Pecten Murchisoni* is preserved in the Science and Art Museum, Dublin. It is a fine specimen of a left valve (Pl. XIV, fig. 3). The marking on the left valve is identical with that of *Pterinopecten Dumontianus*, de Kon., sp., but the latter shell is at once distinguished by its long hinge-line, the long, gradually compressed posterior ear, and the numerous ribs on both ears. The nodulose character of the ribs is not very marked in the type. I have noticed much variation in a suite of specimens from Castleton and Poolvash.

An examination of the type of *Pecten ovatus*, McCoy, preserved in the Museum of Science and Art, Dublin, in the Griffith Collection, has led me to the conclusion that the shell is the young of *A. Murchisoni*. The contour is the same, and so is the general character of the ornament. McCoy figures the secondary thin rib between a pair of large ones in an enlarged view. The shell is so small that only one secondary rib is figured.

AVICULOPECTEN INEQUALIS, sp. nov. Plate XIV, figs. 14, 15.

Specific Characters.—Shell of medium size, inequivalve, the right being much smaller than the left valve, and somewhat flatter, slightly oblique. Antero-posterior

diameter much less than the dorso-ventral diameter, ovato-rectangular. The anterior margin of the valve slightly convex, the lower margin much more so, the posterior margin almost straight. The hinge-line straight. Ears large and depressed, pointed, with each margin falcate; the right anterior ear deeply grooved for the byssus. The posterior ears very deep and long, the fold separating them from the valve reaching the margin low down. Umbones small and pointed, placed in front of the centre of the hinge-line.

Interior.—Unknown.

Exterior.—The surface is ornamented with several distant, obscure, broad, radiating ribs, separated by shallow grooves. The whole surface seems to be smooth. Occasionally there are concentric lines and rugæ of growth. The ears have much the same characters as the rest of the valve.

Dimensions.—Pl. XIV, fig. 14, a left valve, measures—

Antero-posteriorly	.	.	.	37 mm.
Dorso-ventrally	.	.	.	53 mm.

Locality.—Scotland: the Carboniferous Limestone series of Chance Pit 21, Kinneil, near Boness (roof of Smithy Coal).

Observations.—This very characteristic species is founded on a right and left valve on one surface of a slab of shale, and a smaller left valve on the other surface. It would seem that this specimen is referred to in the memoir of the Geological Survey of Scotland, explanation of sheet 31, p. 70, as *Aviculopecten* (near *A. planocostatus*, McCoy, sp.). It is accompanied by a marine fauna, but many of the species mentioned in the list are not named with certainty. Of course this shell has no affinity with *A. planocostatus*, McCoy, sp., which has quite distinct characters; but the original drawing is so hypothetical that it is not to be wondered that other shells have been confused with it. This species is now referred to the genus *Amusium* (see p. 123).

The left valve of *A. inequalis* seems to have been much larger than the right valve, and to have overlapped this on all sides except that of the hinge-line. I have not noticed this character in any other Carboniferous Pectiniform shell; otherwise the shape of the left valve is very similar to that of *A. Murchisoni*.

AVICULOPECTEN DEORNATUS, *Phillips*, sp., 1836. Plate XVIII, figs. 10—14.

PECTEN DEORNATUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 213, pl. vi, fig. 26.

— — — *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 91.

AMUSIUM ? DEORNATUM, *McCoy*, 1855. Brit. Pal. Foss., p. 478.

Specific Characters.—Shell small, broadly ovate, moderately convex, equivalve, almost equilateral. The lower margin almost semi-circularly curved. The hinge-

line straight, of moderate length. Umbones small, acute, central. Ears large, well defined, compressed, the anterior the larger; that of the right valve deeply slit for the byssus; the posterior ear elongate, narrow, and acutely pointed. Shell very thin.

Interior.—Seems to be normal, smooth, without traces of the concentric sulci.

Exterior.—The surface is smooth, crossed by two or three distant, deep sulci, the upper margin of which is at times converted into a concentric ridge.

Dimensions.—Pl. XVIII, fig. 10, a right valve, measures—

Antero-posteriorly	.	.	.	9 mm.
Dorso-ventrally	.	.	.	10 mm.

Locality.—Ireland: the Carboniferous Limestone of Little Island, co. Cork.

Observations.—Phillips's poor figure is accompanied by an even more meagre description, which reads as follows:—"This has scarcely distinguishable characters, yet contrasts with the others by its smooth concentric furrows;" and it is on the latter character alone that I have considered it well to retain the species. McCoy's description is a little more detailed.

I refer to *A. deornatus* a number of specimens from Little Island, co. Cork, in the cabinet of Mr. Joseph Wright, of Belfast. The majority of the specimens consist of right valves, but the left valve is represented. The long hinge-line and pointed ears demonstrate the affinity of the shell to *Aviculopecten*.

A. deornatus is easily diagnosed from *A. Sedgwicki*, the angular concentric ridges of the latter being absent, and the valve being more orbicular and less regularly ovate. *A. interlineatus*, Meek and Worthen, is very similar in appearance to *A. deornatus*.

AVICULOPECTEN SEDGWICKI, *McCoy*, sp., 1844. Plate XVI, figs. 28—33.

PECTEN SEDGWICKII, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 99, pl. xiv, fig. 4.

AVICULOPECTEN SEDGWICKII, *Morris*, 1854. Cat. Brit. Foss., 2nd edit., p. 165.

Specific Characters.—Shell small, longitudinally ovate, the left valve moderately convex, the right flattened. Ears well marked, the anterior depressed, rolled, and pointed, the posterior rapidly compressed and pointed. The hinge-line straight and long, the umbo in the left valve gibbose, pointed, and raised above the opposite valve; the right umbo small, flattened, and placed below the left, below which there seems to be a notch to receive it when the valves were open.

Interior.—Unknown.

Exterior.—The surface is ornamented by a few distant, concentric, acute ridges, not quite so well marked in the right valve, separated by broad, concave, concentric, smooth grooves. The ridges pass on to the ears, the contour of which they follow. Very obscure radiating striae are at times seen crossing the grooves.

Dimensions.—Pl. XVI, fig. 28, a left valve from Cork, measures—

Antero-posteriorly	.	.	.	18 mm.
Dorso-ventrally	.	.	.	24 mm.

Localities.—England: the Carboniferous Limestone of Narrowdale, North Staffordshire; Park Hill, Derbyshire. Ireland: the Carboniferous Limestone of Cork and Little Island, co. Cork.

Observations.—This very characteristic shell is rare, but Mr. Joseph Wright's cabinet contains five specimens, one of which is a bivalved example, though unfortunately not perfect in the neighbourhood of the ears. It shows the left valve to overlap the right valve considerably, and to be much more convex than the latter. The concentric folds are triangular in section, and not rounded as in *Pseudamuseum auriculatum*.

Genus PSEUDAMUSIUM, *H. and A. Adams*, after *Klein*, 1858; emend *Verrill*, 1897.

PSEUDAMUSIUM, *Klein*, 1753.

— *H. and A. Adams* (pars), 1858.

— *Verrill*, 1897. *Trans. Connecticut Acad.*, vol. x, p. 60.

Generic Characters.—Shells nearly equal, the right flatter than the left, ovate or subcircular; margins simple. Ears well defined, small, straight, obtuse-angled. Exterior smooth, or with lightly marked radiating striae or grooves.

Observations.—Prof. Verrill has given a long account of this genus and its limitations in his paper on "A Study of the Family *Pectinidae*" above cited, and it is unnecessary to refer much to the synonymy here. The distribution, according to him, is Recent to Cretaceous. This genus is more closely allied to *Camptonectes*, Meek, most of the species of which are Mesozoic. Prof. Verrill remarks that the latter "is generally regarded as only a section of *Pseudamuseum*." At any rate the relationship between the two genera is so close that it would be impossible to decide to which the Carboniferous examples might the more appropriately be referred. I have therefore adopted that genus which has the right of priority.

PSEUDAMUSIUM ELLIPTICUM, *Phillips*, sp., 1836. Plate XX, figs. 11—18.

- PECTEN ELLIPTICUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 15.
 — — *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 92.
 — ELONGATUS, *McCoy*, 1844. Ibid., p. 92, pl. xvi, fig. 9.
 — DEPILIS, *McCoy*, 1844. Ibid., p. 91, pl. xvi, fig. 11.
 — FILATUS, *McCoy*, 1844. Ibid., p. 93, pl. xiv, fig. 10.
 — ELLIPTICUS, *de Verneuil*, 1845. Géol. Russie de l'Europe, p. 329, pl. xxi, fig. 8.
 AVICULOPECTEN ELLIPTICUS, *Morris*, 1854. Cat. Brit. Foss., 2nd edit., p. 164.
 PECTEN ELONGATUS, *de Koninck*, 1877. Recherches Foss. Pal. New South Wales, p. 155, pl. xxii, fig. 5.
 STREBLOPTERIA ELONGATA, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 205, pl. xxxii, fig. 8.

Specific Characters.—Longitudinally ovate, below medium size, moderately and regularly convex. The margin one unbroken curve from ear to ear. Hinge-line small and straight. Anterior ears small, triangular, depressed, that of the right valve separated from the margin of the valve by a deep groove. Posterior ears small, triangular, depressed. Umbones pointed, central, moderately swollen.

Interior.—The hinge-plate is triangularly elongate, smooth (only the anterior third has been seen). Adductor muscle-scar normal.

Exterior.—The surface, including the ears, is smooth. Occasionally concentric striæ or irregularities of growth are seen, and some examples have obscure, radiating, obsolete ribs, especially near the anterior margin, often marked with radiating colour-bands on the left valve.

Dimensions.—Pl. XX, fig. 13, the type of *Phillips's Pecten ellipticus*, measures—

Antero-posteriorly	.	.	.	25 mm.
Dorso-ventrally	.	.	.	31 mm.

Localities.—England: the Carboniferous Limestone of Thorpe Cloud, Park Hill, and Castleton, Derbyshire; Narrowdale, North Staffordshire; Hill Bolton, Yorkshire. Scotland: the Upper Limestone series of Bowertrapping; Genwhappleburn, Craigenglen. Ireland: the Carboniferous Limestone of Rathkeale, Askeaton, and Curraghbeg, co. Limerick; Little Island, co. Cork; Townplots, Killala, co. Mayo; Millicent, co. Kildare.

Observations.—The type of *Pecten ellipticus*, *Phillips*, is preserved in the Gilbertson Collection, Natural History Museum, South Kensington, and I figure it in Pl. XX, fig. 13. It is a left valve, imperfect in front, and shows the short ears and general contour of the valve. It does not show, however, the radiating lines and colour-bands so commonly found in examples of this species. The type is rather more elliptical than most of the specimens I have studied, and perhaps for

this reason McCoy did not recognise that his *Pecten elongatus* belonged to Phillips's species. The shell in the Gilbertson Collection labelled *P. elongatus* (Pl. XX, fig. 14) can hardly have been the figured specimen, as it is so much smaller than the figure, but both figure and specimen are left valves. Both Phillips's and McCoy's specimens are so smooth that I think it likely they were casts. De Koninck adopted McCoy's name, and does not appear to have considered that Phillips's shell occurred in Belgium.

After examination of the types in the Science and Art Museum, Dublin, I cannot but refer *P. depilis*, McCoy, to Phillips's species. It is a smaller shell, but the contour of the valve and general shape show its close affinity to *P. ellipticum*. I think *P. filatus* of the same author also belongs to Phillips's species. I am unable to identify the radiating lines, as shown in the enlarged figure, in the specimen which is now considered to be the type. It is not *P. anisotum*, for the ears are not ribbed, but are plain.

PSEUDAMUSIUM ANISOTUM, *Phillips*, sp., 1836. Plate XXI, figs. 13—20.

PECTEN ANISOTUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 212, pl. vi, fig. 22.

— CONSIMILIS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 91, pl. xv, fig. 16.

— VARIABILIS, *McCoy*, 1844. Ibid., p. 101, pl. xvi, fig. 7.

LIMA OBLIQUA, *McCoy*, 1844. Ibid., p. 88, pl. xv, fig. 7.

cf. PECTEN SIBERICUS, *de Verneuil*, 1845. Geol. Russie de l'Europe, p. 329, pl. xxi, fig. 7.

— ANISOTUS, *Brown*, 1849. Illust. Foss. Conch., p. 156, pl. lxx, fig. 24.

AVICULOPECTEN ANISOTUS, *Morris*, 1854. Cat. Brit. Foss., 2nd ed., p. 164.

— — *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 237, pl. xxxix, fig. 22.

cf. STREBLOPTERIA RENARDI, *de Koninck*, 1885. Ibid., p. 203, pl. xxxiv, fig. 27.

Specific Characters.—Shell below medium size, almost equivalve, inequilateral, obliquely rotundato-ovate, only moderately convex. The margin continuously convex from ear to ear, more so in front, where the anterior border is produced. The hinge-line straight and short. The umbones small, triangular, pointed, flattened, slightly raised, placed about the centre of the hinge-line, but posterior to the median vertical diameter of the valve. The anterior and upper part of the valve much cut away for the byssal notch, and the border extending forwards considerably beyond the anterior ear. The anterior ears well marked, depressed, well defined from the valve, separated in the right by a slit for the byssus; the posterior ears very small, triangular, compressed, the posterior superior angle very obtuse. Shell very thin.

Interior.—The adductor muscle-scar large and normal in position. The lower part of the left valve obscurely ribbed internally.

Exterior.—The surface of both valves is quite smooth, with an occasional concentric sulcus, pointing to interference with growth. Several specimens show narrow, radiating, and concentric colour-bands. Both anterior ears are crossed by several moniliform radiating ribs.

Dimensions.—Pl. XXI, fig. 13, the type, measures—

Antero-posteriorly	14 mm.
Dorso-ventrally	16 mm.

Localities.—England: the Carboniferous Limestone of Thorpe Cloud, Park Hill, and Castleton, Derbyshire; Narrowdale, Staffordshire; Hill Bolton and Settle, Yorkshire; five feet above Underset Limestone, Goodham Gill, Swarth Fell, Westmoreland; White Limestone, Poolvash, Isle of Man. Scotland: shore east of Kinghorn; shore west of Kinning Point, Charlestown; Cockmuir Quarry, Hillhead Bridge, Denny. Ireland: Carboniferous Limestone of Little Island and Ballydaniel, co. Cork; Doohylebeg, co. Limerick.

Observations.—The type-specimen (Pl. XXI, fig. 13) is preserved in the Gilbertson Collection, Natural History Museum, South Kensington. It is a right valve and not very perfect. The species is easily recognised by the smooth surface of both valves, and it is very common in the shell beds on Thorpe Cloud, Dovedale, but it is difficult to obtain whole from the matrix. The valves vary a good deal in breadth, and there is a tendency for the shells to become less ovate and more orbicular with age, and I imagine that several of de Koninck's species represent different states of *P. anisotum*. De Koninck referred the species to *Aviculopecten* in the text, but with a (?) in the explanation of the plates; I am at a loss to understand why he retained the species in the genus *Aviculopecten*. *P. anisotum* is more oblique, less tumid, and broader than *P. ellipticum*.

P. sibericum, de Verneuil, is, I think, probably the same shell as Phillips's *P. anisotum*. The drawing of the Russian shell represents a right valve, showing an anterior ear, which has a reticulate character; this and the smooth, slightly sulcated, broad ovate valve, seem to me to leave little doubt as to the identity of the shell.

I consider that *Pecten consimilis*, McCoy, is merely the young of Phillips's shell. McCoy called attention to the striation of the anterior ears, which is a characteristic feature. I think that *P. variabilis*, McCoy, represents a rather medium-sized specimen of Phillips's species, but the type-specimens are so obscure that their true nature is quite uncertain. *Lima obliqua*, McCoy, also seems to me to be a fragment of *P. anisotum*.

PSEUDAMUSIUM GIBBOSUM, *McCoy*, sp., 1844. Plate XXI, fig. 12.

PECTEN GIBBOSUS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 93, pl. xviii, fig. 5.

Specific Characters.—Shell small, orbicular, very convex, the contour from ear to ear nearly circular. The hinge-line straight, fairly long. The umbo tumid, incurved, and pointed, raised above the hinge-line in the left valve. The ears narrow and elongate; the anterior ear deeply separated from the valve by a curved groove, the posterior ear with its posterior superior angle a right angle.

Interior.—Unknown.

Exterior.—The surface of the left valve is ornamented with fine, microscopic, radiating lines apparent only on the anterior third of the valve; there are also very fine, close, concentric lines visible with the microscope. The ears appear to be smooth. The right valve has a similar ornament.

Dimensions.—Pl. XXI, fig. 12, a left valve from Castleton, measures—

Antero-posteriorly	20 mm.
Dorso-ventrally	20 mm.
Gibbosity of the valve	5 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire. Ireland: Ballyduff, Dungarvan, co. Waterford.

Observations.—I am doubtful if the type of *McCoy's Pecten gibbosus* is preserved in the Griffith Collection, Science and Art Museum, Dublin. The specimen is a left valve, much larger and much flatter than the figure, which represents a right valve, and the ears are much longer than those in the figure. I have only met with one other specimen of this species, a left valve. *McCoy's* description is very definite and accurate; his observations on the species are:—"This little species is almost globular. The small lengthened ear is perfectly flat, and distinctly separated from the body of the shell."

PSEUDAMUSIUM FIBRILLOSUM, *Salter*, sp., 1864. Plate XVI, figs. 16—22.

AVICULOPECTEN FIBRILLOSUM, *Salter*, 1864. Mem. Geol. Survey, Geol. of Country round Oldham, p. 65, pl. i, fig. 2.

PECTEN PRÆTENUIS, von *Koenen*, 1879. Neues Jahrb. f. Min., p. 329, taf. vi, figs. 3, 4.

AVICULOPECTEN CAIRNSII, *Bolton*, 1897. Mem. Manch. Lit. and Phil. Soc., vol. xli, No. 6, p. 3.

PECTEN (PLEURONECTITES) cf. PRÆTENUIS, *Wolterstorff*, 1899. Untercarbon. Magdeburg-Neustadt, p. 47, pl. iii, figs. 8—16.

Specific Characters.—Shell below medium size, ovate, slightly oblique, the left valve a little more convex than the right valve. The anterior margin cut away under the anterior ear, descending outwards and downwards with a slightly concave curvature till it meets the convexity which is continued round the lower margin, making a rounded obtuse angle; the posterior margin rapidly approaching the umbo, forming a well-marked ridge which limits the posterior ear. The ears depressed, small, triangular, the posterior smaller than the anterior. Byssal notch deep. Hinge-line short and straight. The umbones small, pointed, sub-central.

Interior.—Unknown.

Exterior.—The right valve is marked with irregular fine or coarse concentric lines and striae of growth, radiating striae obsolete. Ears apparently smooth. The left valve is ornamented with many fine, close, irregular, radiating, fibrillose striae, crossed by concentric lines and rugae of growth. Ears with fine radiating striae. Periostracum thick, often wrinkled, probably from pressure.

Dimensions.—Pl. XVI, fig. 22, a right valve, measures—

Antero-posteriorly	25 mm.
Dorso-ventrally	25 mm.

Localities.—England: Coal Measures, 150 yards over Great Mine Coal, river at Ashton-under-Lyne; above the Gin Mine Coal, Nettlebank Sinking, Smallthorne, North Staffordshire; marine bed in Middle Coal Measures, River Tame, Dukinfield; Pendleside Series, Leek and Waterhouses Railway, Staffordshire; and at Holden and Pendle Hill, Lancashire. Ireland: (?) Coal Measures, Slieve Carna, co. Mayo.

Observations.—This species was established by Salter for some shells found in the banks of the river Tame, at Ashton-under-Lyne. The series of shells used for description and illustration are preserved in the collection of the Geological Survey, Jermyn Street, and I have been permitted to study them. The illustrations are somewhat hypothetical, as the right valve in well-preserved specimens is free from radiating striae, and in full-grown specimens, where the periostracum is very thick, they are not always seen in the left valve. The narrow hinge-line and small ears, of which the anterior is larger than the posterior, are, however, correctly indicated. I have met with this species in a much finer condition in beds of the Pendleside Series at Holden, Bolland, and have referred the shell in lists of fossils to *Pecten prætennis*, von Koenen. I have arrived at the conclusion that this species is identical with Salter's shell, and placed the name as a synonym of *Pseudamusium fibrillosum*. Wolterstorff has given some good figures of the species, referring it to von Koenen's *Pecten prætennis*.

It is of interest to note that *P. fibrillosum* is found in the Pendleside Series and Coal Measures of England and Ireland, and in the Culm beds of Herborn and Magdeburg, one of several species common to these localities, and indicating a

faunal relationship between the Culm and Pendleside Series. I have not met with the species in the Lower Carboniferous Series.

PSEUDAMUSIUM AURICULATUM, *McCoy*, sp., 1844. Plate XVI, figs. 23—27.

LIMA LÆVIGATA, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 88, pl. xiv, fig. 3

INOCERAMUS AURICULATUS, *McCoy*, 1844. Ibid., p. 77, pl. xix, fig. 5.

PECTEN CINGENDUS, *McCoy*, 1844. Ibid., p. 90, pl. xvii, fig. 11.

cf. AVICULOPECTEN ? CONCENTRICO-COSTATUS, de *Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 237, pl. xxxi, figs. 6, 7; pl. xli, figs. 28—33.

Specific Characters.—Shell below medium size, inequivalve, the left valve gibbose, the right valve less so; ovate, orbicular, oblique. The anterior margin below the ear produced and rounded; the lower margin broadly round; the posterior margin almost straight, making a right angle with the hinge-line, which is straight and of medium length. The umbones gibbose, incurved, and pointed, the left the higher, more swollen, and arching over the right. The anterior ear well marked off from the valve, depressed and small, separated in the right valve by the byssal slit; the posterior ear large and ill-defined, its margin rectangular.

Interior.—Unknown.

Exterior.—The surface is smooth, but raised into several concentric ribs in both valves, which become obsolete towards the posterior superior angle of the valve. The ears seem to be smooth.

Dimensions.—Pl. XVI, fig. 25, a bivalved example in the collection of the Geological Survey of Ireland, measures—

Antero-posteriorly	.	.	.	.	16 mm.
Dorso-ventrally	.	.	.	.	18 mm.
From side to side	.	.	.	.	9 mm.

Localities.—Ireland: the Carboniferous Limestone of Middleton and Little Island, co. Cork; Abbeybay, Ballyshannon, co. Donegal; Croag and Knocksouna, co. Limerick; Millicent, Clane, co. Kildare.

Observations.—The type of *Inoceramus auriculatus*, *McCoy*, is stated to have been in the collection of Dr. Haines, of Cork, but I have not been able to trace it. Kelly states that it came from co. Cork.¹ I have no hesitation in referring *Pecten cingendus*, *McCoy*, the type of which is in the Griffith Collection, Royal College of Science Museum, Dublin, to this species. The latter is a right valve, evidently

¹ 'Journ. Geol. Soc. Dub.,' vol. vii, p. 12.

somewhat compressed, hence its flattened condition. An almost perfect bivalved example is in the collection of the Geological Survey of Ireland (Pl. XVI, fig. 25).

The name *P. auriculatum* has been adopted, as it occurs in M'Coy's work several pages in advance of *Pecten cingendus*, and therefore has the priority.

His species is easily distinguished from *A. Sedgwicki*, in which shell the concentric ribs are angular and acute. It seems to me that the species is most likely to be mistaken for small, incomplete specimens of *Posidoniella vetusta*, in which there is no anterior ear, and the whole shell is more oblique. *Aviculopecten? concentrico-costatus*, de Koninck, is probably a young form of M'Coy's species, which accounts for the number and closeness of the concentric ribs.

The type of *Lima lævigata*, M'Coy (Pl. XVI, fig. 24), is evidently only a full-grown example of the left valve of *P. auriculatum* distorted by shearing.

PSEUDAMUSIUM REDESDALENSE, sp. nov. Plate XX, figs. 1—6.

Specific Characters.—Shell below medium size, obliquely suborbicular, sub-equivalve, the left valve the more convex. The margin one single curve, most convex and produced in front; the hinge-line short and straight. The umbones small, pointed, very slightly raised, and situated about the centre of the hinge-line, and therefore posterior to the middle vertical diameter of the valves. The ears small, the anterior in the right valve well defined, divided from the valve by a deep, broad, scimitar-shaped groove for the byssus, that of the left valve triangular and sharply depressed. The posterior ears small and triangular in both valves, their posterior margin vertical.

Interior.—The adductor muscle-scar is large, oval, and placed posterior to the middle line above the centre of the valve from above downwards. The pallial line is remote from the margin. The inner surface of the left valve below the pallial line is marked by flat radiating ribs, the right valve being quite smooth. Flat radiating colour-bands of considerable thickness often present. The hinge shows an elongate groove for the ligament.

Exterior.—The surface of the right valve is smooth, but the anterior ear has imbricating concentric lines. The left valve has almost obsolete, flat, radiating ribs, covered with fine, close, linear, radiating striæ in its lower two-thirds. Apparently smooth in the upper third.

Dimensions.—Pl. XX, fig. 3, a bivalved example, measures—

Antero-posteriorly	.	.	.	25 mm.
Dorso-ventrally	.	.	.	25 mm.
From side to side	.	.	.	8 mm.

Localities.—England: the Redesdale Ironstone Beds, Redesdale, Northumberland. Scotland: Lower Carboniferous of Thornton Burn, Haddington.

Observations.—This species has the characteristically expanded anterior side of *Streblopteria*, but with a short hinge-plate. It differs from other described species of the genus in having the left valve ornamented with flattened ribs covered with fine radiating lines, while the right valve is smooth. The interior of the valve also shows the flat ribs. The majority of the species of the genus are smooth, but even in some of these there are well-marked radiating colour-bands.

De Koninck describes two of his species, *L. ellipsoidea* and *S. pleurophora*, as having radiating striæ. In the former these striæ arise some distance from the umbo, and in the latter it is stated that the striæ are more marked near the margin; but it is not noted that only the left valve is so ornamented, though it is the left valve which is figured in both cases.

P. Redesdalense resembles *P. propinquum*, de Koninck, in general shape, and it is possible that the species may be one; but no radiating ribs are figured or described as being present in the Belgian shell.

In Prof. Lebour's list of the shells from the Redesdale Ironstone beds ('Hand-book Geol. and Nat. Hist. Northumberland and Durham,' p. 121) four species of *Aviculopecten* are enumerated, namely, *A. planoradiatus*, McCoy; *A. papyraceus*, Sow.; *A. concavus*, McCoy; *A. calutus*, McCoy, and a new species. It is probable that *P. Redesdalense* was mistaken for *A. planoradiatus*, which I have not met with there; but the hinge, ears, and general shape of the shell are very different. Of course, *Pterinopecten papyraceus* does not occur at this locality.

PSEUDAMUSIUM SUBLOBATUM, Phillips, sp., 1836. Plate XVII, figs. 11—14.

AVICULA SUBLOBATA, Phillips, 1836. Geol. Yorks., pt. ii, p. 211, pl. vi, fig. 25.

— — — Brown, 1849. Illust. Foss. Conch., p. 162, pl. lxxi**, fig. 32.

AVICULOPECTEN SUBLOBATUS, Morris, 1854. Cat. Brit. Foss., 2nd edit., p. 166.

— — — R. Etheridge, jun., 1876. Geol. Mag., dec. ii, vol. iii, p. 151, pl. vi, figs. 2—6.

Specific Characters.—Shell below medium size, slightly obliquely oval, somewhat inequivalve, the left valve regularly and very convex, the right less so. The greater part of the margin of the valve regularly curved, but the curvature apparently terminating both in front and behind in a kind of shoulder, above which the edge of the valve slopes inward to the base of each ear. The hinge-line probably very short. The right anterior ear small, but deeply separated from

the valve by a wide, scimitar-shaped slit for the byssus; the right posterior ear almost obsolete. The left anterior ear ill-defined, rolled, and small; the posterior ear still smaller. The umbones gibbose, subcentral, and pointed.

Interior.—Unknown.

Exterior.—The surface of both valves is ornamented with radiating bands of colour, varying in width and number. The surface of the valves is almost smooth, but the microscope shows fine concentric lines and striæ. The anterior side of the right valve shows close radiating ribs, which extend to the border, but become gradually obsolete from before backwards.

Dimensions.—Pl. XVII, fig. 13, a left valve, measures—

Antero-posteriorly	.	.	.	.	25 mm.
Dorso-ventrally	.	.	.	.	21 mm.
Convexity of valve	.	.	.	.	5 mm.

Localities.—England: the Carboniferous Limestone of Park Hill and Castleton, Derbyshire. Ireland: the Carboniferous Limestone of Little Island, co. Cork.

Observations.—Mr. R. Etheridge, jun., re-described and figured Phillips's species. He figured five specimens which are in the Museum of the Geological Survey, Jermyn Street, and I am kindly permitted to figure four of them (Pl. XVII, figs. 11—14). Unfortunately no single specimen is absolutely perfect, but at least two are right valves. The posterior ears are almost obsolete, but the anterior ears are well developed.

The type of *Avicula sublobata*, Phillips, has unfortunately disappeared; but, in spite of the poor figure and meagre description, I think there is no doubt that Mr. Etheridge, jun., was quite correct in referring his specimens to that species. He discusses at length the peculiar size and number of the colour-bands as indicated in the figures, and thinks that the shell shows some doubtful affinity to *Streblopteria*, McCoy; but the absence of the large and expanded posterior ears at once necessitates its removal from that genus. I therefore have placed it under the genus *Pseudamusium*.

PSEUDAMUSIUM CONCENTRICO-LINEATUM, sp. nov. Plate XX, figs. 7—10.

Specific Characters.—Shell of medium size, equivalve, equilateral, almost circular, moderately gibbose. The anterior, lower, and posterior margin formed by a regular curve, almost circular in form. The hinge-line straight, of moderate length. The umbones small, pointed, not raised, subcentral. The right anterior ear well marked and separated from the valve by a deep byssal slit; that of the left valve depressed, deep, and somewhat rolled. The posterior ears smaller than

the anterior ears, triangular, the posterior superior angle being only very slightly obtuse. Shell thin.

Interior.—Smooth. Muscle-scar in normal situation. Hinge not known.

Exterior.—Both valves are adorned with regular, concentric, flattened ridges, separated by shallow, linear, concentric grooves, which are much closer together and more numerous on the left than on the right valve, and also are crowded and less regular near the lower margin. On the left valve the concentric ridges are crossed by fine radiating lines, most marked at the anterior border. The anterior ears have fine radiating and concentric ridges, while the posterior ears are almost smooth.

Dimensions.—Pl. XX, fig. 10, a left valve, measures—

Antero-posteriorly	.	.	.	.	50 mm.
Dorso-ventrally	.	.	.	.	48 mm.
Elevation of valve	.	.	.	.	7 mm.

Localities.—England: the Carboniferous Limestone of Wetton, Staffordshire; Castleton, Derbyshire. Ireland: the Carboniferous Limestone of Askeaton, co. Limerick.

Observations.—The marking of the right valve might be mistaken for that of *A. dissimilis* if the ears were not preserved, but the latter shell is much flatter and not so circular. The hinge-line and ears are totally different in character. The species is not common, but has a fairly wide distribution. The valves seem to be equally convex, but as I have not obtained a bivalved example, I cannot be certain on this point. The shell was very thin, and if the specimens are at all rolled the characteristic concentric lines and spaces are obliterated. The ears and the length of the hinge-line show the real generic affinity. The general form and ornament have some resemblance to the Cretaceous *Pecten cinctus*, Sow.

Genus CRENIPecten, Hall, 1883.

CRENIPecten, Hall, 1883. Pal. N. York, vol. v, pt. 1, plates and exp., p. 3.

— — 1885. Ibid., vol. v, pt. 1; Lamell., vol. i, p. 81.

Generic Characters.—Shell Pectiniform, ears well developed, smooth, the anterior ear the larger (Hall). Hinge with a number of small, close, subequal, parallel, vertical, ligamental pits or teeth throughout its entire length. Surface smooth or radiated.

Observations.—This genus was founded by Hall for shells possessing the peculiar hinge-characters described above. It differs from *Pernopecten*, Winchell, which

has the shape of *Synclonema* and *Amusium*, but has a central cartilage pit and a row of vertical, narrow pits, which are arranged, not in a straight line, but each series rises slightly from the centre outwards. It also differs from *Euchondria*, Meek, which has an excentric cartilage pit, and the lateral pits unequal on the two sides.

All the species figured by Hall, except one, *C. Winchelli*, are smooth, with a short hinge-line and small ears; but the species just mentioned has a long hinge-line, large ears, and well-marked, numerous, radiating ribs. The only British shell which shows the characteristic hinge-plate of *Crenipecten* resembles the latter species very closely. Prof. Hall says of it:—"This species differs from any known form of *Crenipecten*. It is like *Ariculopecten* in external form and surface characters, and resembles the recent genus *Pecten* . . . Except in the hinge crenulations, this form has no other relations with the genus *Crenipecten*, and it may be found to belong to some genus yet undescribed, which will include other species, now placed with the Carboniferous forms of *Ariculopecten*."

CRENIPECTEN SEMICIRCULARIS, *McCoy*, sp., 1844. Plate XV, figs. 21—23.

PECTEN SEMICIRCULARIS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 99, pl. xvii, fig. 10.

Specific Characters.—Shell of medium size, almost equivalve, the valves moderately convex, transversely semicircular. The margin regularly rounded, extending in front of the anterior ear, markedly falcate posteriorly where it joins the posterior ear. The hinge-line straight, long, projecting beyond the posterior margin. The unbones small and inconspicuous, not raised, central. The anterior ears depressed and well defined from the body of the valve, that of the right valve slit for the byssus; the posterior ears long, large, and well defined, the posterior border very falcate.

Interior.—Smooth.

Exterior.—The surface of the right valve is ornamented with very numerous, fine, somewhat irregular, rounded ribs on the body of the valve, totally absent on the posterior ear, and with only five on the anterior ear. These ribs are crossed by concentric lines and rugæ of growth, which are well marked on the posterior ear. The same ornament occurs on both valves.

Dimensions.—Pl. XV, fig. 21, a left valve, measures—

Antero-posteriorly	.	.	.	.	72 mm.
Dorso-ventrally	.	.	.	.	61 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire; Poolvash, Isle of Man; Underset Limestone of Farcote Gill, Wildboar Fell, Westmoreland. Scotland: the Lower Limestone series of Thornton. Ireland: the Carboniferous Limestone of Bruckless, Dunkineely, co. Donegal.

Observations.—McCoy founded his species on a mere fragment, probably the impression of the exterior of a right valve, but not possessing sufficient details to warrant the drawing of the anterior ear. The peculiar character of the numerous fine radiating ribs is, however, well marked in the type-specimen.

The large and almost smooth posterior ears, quite free in their greater part from radiating ribs, is an important character, and prevents any confusion between this shell and *Pterinopecten concavus*, which has a somewhat similar marking, but differs totally in the characters of its ears. There seems to be little or no difference between the convexity and markings of both valves.

I am able to figure both valves. The left valve (Pl. XV, fig. 21) is from the cabinet of Mr. R. Law, who obtained the specimen from Castleton. The right valve is a specimen from Derbyshire in the Wood Collection, York Museum (Pl. XV, fig. 23). I obtained a fragment, showing the hinge-plate, from the Underset Limestone, high up in the Yoredale Series of Lunedale. It shows the peculiar ears and markings of McCoy's shell, in addition to the characteristic hinge-plate of *Crenipecten*. The hinge-plate is a little imperfect at the centre, and evidently belongs to a right valve (Pl. XV, fig. 22).

C. semicircularis, McCoy, closely resembles *C. Winchelli* from the Waverley Sandstone, Newark, Ohio, but has a rather longer hinge-plate, and is generally more transverse. It seems to me that Hall was mistaken in stating that the anterior ear is larger than the posterior ear. Pl. ix, figs. 27, 28, of his monograph, evidently represent left valves, as he states they show the posterior ear to be the larger; but, as I have quoted above, he regards *C. Winchelli* as an aberrant generic form. It is interesting, therefore, to see a shell with such similar characters present in the Carboniferous Strata of England.

Genus OBLIQUIPECTEN, nov.

Generic Characters.—Shell compressed, with the anterior end much developed; the posterior end almost obsolete. The left valve flattened, with a large anterior ear; posterior ear almost obsolete. The right valve with a large anterior ear, the posterior part of the valve bent on itself obliquely downwards and forwards. Hinge-line small. Umbones pointed, curved forwards, and flattened.

Exterior.—The surface, almost smooth, is ornamented by fine concentric lines of growth.

Observations.—This is a very curiously shaped shell, with a strong Pectiniform character; but one cannot look at the left valve without the *Ostrea*-like form calling for comment. The right valve is the more common. A single specimen of the left valve from Settle is in the Woodwardian Museum, Cambridge, and I know no other.

OBLIQUIPECTEN LÆVIS, sp. nov. Plate XIX, figs. 1, 2.

Specific Characters.—Shell of moderate size, compressed, obliquely extended in front, truncate behind, very inequivalve, the right valve being the more convex; very inequilateral, the posterior portion being almost obsolete. Anterior border descending from the umbo, curved rapidly outwards so that the edge of the valve is deeply concave in the region of the anterior ear, the valve below this becoming very convex. The lower margin convex, the posterior margin more gently curved. The hinge-line short, especially behind the umbo, which is flattened, pointed, and curved forwards, placed at the junction of the posterior and middle thirds of the hinge-line. The anterior ears large, especially that of the right valve, which is expanded above the hinge-line and deeply notched for the byssus below. The posterior ears very small, but definite. The right valve bent suddenly on itself along a curved line which passes downwards and forwards from below the posterior ear, the angle of flexion gradually becoming less as it approaches the lower border.

Interior.—Unknown.

Exterior.—The surface is almost smooth, but the microscope shows it to be ornamented with fine concentric striae and lines of growth. The right anterior ear has concentric lines, and the left ear shows fine radiating lines.

Dimensions.—Pl. XIX, fig. 2, a left valve from Settle, measures—

Antero-posteriorly	.	.	.	37 mm.
Dorso-ventrally	.	.	.	45 mm.

Localities.—England: the Carboniferous Limestone of Settle and Hill Bolton, Yorkshire; Castleton, Derbyshire; and Narrowdale, Staffordshire.

Observations.—This very peculiarly shaped species is not likely to be confounded with any other. The right valve is recognised by the marked flexure of the valve near its posterior border. The Woodwardian Museum, Cambridge, has a set of seven specimens from Settle, six of which are right valves. The peculiarly expanded anterior ear, with its deep slit for the byssus, is not met with in other Pectiniform shells. The species is not common, but I have found it myself in the localities named above, which are all on the same horizon.

Genus SYNCYCLONEMA, Meek, 1864.

SYNCYCLONEMA, Meek, 1864. Smithsonian Check-list N. Amer. Cret. Foss., p. 31.

ENTOLIUM, Meek, 1864. Geol. California, vol. i, p. 478.

Generic Characters.—Shell Pectiniform, ovate, compressed, equivalve; ears small, triangular. In the left valve the anterior larger, and both projecting upwards; umbones small and acute, depressed and central. The triangularly shaped body of the shell marked off by two broad diverging grooves from the expanded anterior and posterior margins. No byssal orifices beneath the anterior ear.

Interior.—Hinge with a small cartilage pit at the centre, and a linear, horizontal groove on either side. Two deep, oblique, strong ridges diverge from the umbo, triangular in shape, terminating abruptly, seen as grooves in casts, probably hinge-teeth. Starting below these teeth, and internal to them, broad, oblique, shallow ridges pass downwards and towards the margins, separating the body of the valve from the curiously expanded borders. The adductor muscle-scar is large, shallow, central, and close below the umbonal region.

Exterior.—The surface is almost smooth, or covered with concentric striæ and lines of growth. In decorticated specimens fine radiating striæ and zigzag markings are seen, especially near the lower border of the valve.

Observations.—When describing the peculiar characters of *P. Sowerbyi* in 1844, McCoy stated that it agreed with certain Oolitic forms, but mentioned no species. Later on ('Brit. Pal. Foss.,' 1855, p. 478) he referred his species to the genus *Amusium*, Megerle, from which it seems to differ solely in the absence of internal radiating ribs, and possibly in the gaping lateral margins. To *Amusium* McCoy referred *Pecten Sowerbyi*, McCoy, and *P. deornatus*, Phillips, but I cannot accept the latter shell as belonging to the same genus as the former. *P. deornatus* has not the peculiar shape of *S. Sowerbyi*, and Phillips describes it as follows:—"This has scarcely distinguishable characters, yet contrasts with the others by its smooth concentric furrows." Had this type, which, indeed, has unfortunately disappeared, possessed the peculiar characteristics of *Syncyclonema*, Phillips could not have described it in these terms.

In 1864 Meek proposed the name *Entolium* for a Jurassic species which has all the important characters distinguishing the Carboniferous shell. He reviews this new genus at length ('Min. Rep. Nebraska' [U. S. Geol. Surv., 1872], p. 190) when describing a shell from the Carboniferous beds of Nebraska, which is probably identical with the British species. He writes:—"At the time of proposing this name I was under the impression that the valves of these shells were closed on

each side, but the species here under consideration (*E. aviculatum*, Swallow, sp.) seems to have been gaping on the sides above the middle. This being the case, I am not sure the group is more than sub-generically distinct from *Pseudamusium*, Brug., 1789. It differs from *Amusium* mainly in having no internal costæ, and in having the valves more nearly equal, with sometimes minute radiating striae, and no traces of a sinus under the anterior ear in either valve." There is, therefore, a very close relationship between *Entolium* and *Amusium*.

The genus *Pernopecten*, Winchell, is closely allied to *Entolium*, and differs only in having a crenulated hinge-line formed by a row of pits placed on either side of the cartilage pit. I doubt if the genera could be distinguished if the hinge were not exposed, as the external characters are so very similar. The two genera stand to each other in the same relation that *Aviculopecten* stands to *Euchondria*, Meek, and *Orenipecten*, Hall, probably synonyms. This tendency of different genera to develop along parallel lines is of great phylogenetic interest. Hall in 1885 ('Pal. New York,' vol. v, part 1; 'Lamell,' part ii, p. 57) gives a long and comprehensive note on the synonymy of *Entolium*, and Mr. R. Etheridge, jun. ('Geol. Mag.' dec. ii, vol. iv, 1877, p. 241), has also discussed the peculiar characters of the genus at length, giving good and accurate drawings of the hinge-plate and showing the generic identity of the Carboniferous and Jurassic species. Unfortunately no one recognised that the genus occurred also in the Cretaceous beds, and had been described by Meek in 1864 (*loc. cit.*) as *Syncyclonema*, and therefore this generic term has the priority to *Entolium*. Nor was it recognised that shells with a ribbed internal surface, and other characters common to *Amusium*, existed in Carboniferous beds side by side with those having a smooth internal surface.

It is interesting, therefore, to note the persistence of *Syncyclonema* from Carboniferous to Cretaceous times, and *Amusium* from Carboniferous to Recent. It is most difficult to separate species of the two genera unless the interior is exposed, and they are most closely related.

At present only two species of *Syncyclonema* are known from Carboniferous rocks, one of these occurring in the Coal Measures; but three species of *Amusium* have been found. De Koninck referred five species from the Carboniferous rocks of Belgium to *Entolium*, and at least two of these must be now removed to *Amusium*.

I have not been able to satisfy myself as to the condition of the ears in both valves, *i. e.* whether both valves have the ears raised above the hinge-line so as to prevent opening. The left valve always seems to have one or both ears so raised, but the right valve has the hinge-line straight in the majority of cases. This may be due to fracture, for there seems no necessity for the valves to open if the sides are not closed, and there may be compensation in the flange-like expansions of the sides of the valve.

It is also very difficult to ascertain the side to which the valve belongs. I think, however, that the anterior ear is narrower and longer, and is a little better defined from the rest of the valve than the posterior ear.

SYNCYCLONEMA SOWERBYI, *M'Coy*, sp., 1844. Plate XVIII, figs. 21—26.

- PECTEN SOWERBYI, *M'Coy*, 1844. Synops. Carb. Foss. Ireland, p. 100, pl. xiv, fig. 1.
 -- VALDAICUS, *de Verneuil*, 1845. Murchison's Geol. Russia, vol. ii, p. 328, pl. xxvii, fig. 9.
 -- SOWERBYI, *Morris*, 1854. Cat. Brit. Foss., 2nd edit., p. 175.
 AMUSIUM SOWERBYI, *M'Coy*, 1855. Brit. Pal. Foss., p. 478.
 AVICULOPECTEN SOWERBYI, *Armstrong and Young*, 1871. Trans. Geol. Soc. Glasg., vol. iii, App., p. 47.
 ENTOLIUM AVICULATUM, *Hayden*, 1872. Rep. U. S. Geol. Surv., p. 189, pl. ix, figs. 11 *a*—11 *g*.
 PECTEN (PSEUDAMUSIUM) BATHUS, *de Koninck*, 1873. Rech. Anim. Foss. Carb. Bleiberg, p. 94, pl. iii, fig. 19.
 -- SOWERBYI, *R. Etheridge, jun.*, 1874. Geol. Mag., dec. ii, vol. i, p. 300, pl. xiii, figs. 1, 2.
 -- -- *Baily*, 1875. Figs. Char. Brit. Foss., p. 113, pl. xxxix, fig. 3.
 --- (AMUSIUM ?) SOWERBYI, *R. Etheridge, jun.*, 1877. Geol. Mag., dec. ii, vol. iv, p. 241, pl. xii, figs. 1—3.
 ENTOLIUM SOWERBYI, *R. Etheridge, jun.*, 1878. Ann. Mag. Nat. Hist., ser. 5, vol. ii, p. 30, pl. i, figs. 4, 5.
 Non -- -- *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 241, pl. xxxiii, figs. 5, 6.

Specific Characters.—Shell below medium size, ovato-elliptical or suborbicular, almost equivalve, and equilateral. The valve formed of a central, pear-shaped, convex portion, bounded in front and behind by an oblique groove, which separates broad, flange-like, flattened lobes. The margin of the valve convexly curved for the greater part of its extent, but near the upper part of the valve both in front and behind, becoming suddenly bent towards the middle line of the valve at a bluntly obtuse angle, then passing upwards and inwards till it meets the ear. The ears are small, triangular, the anterior somewhat better demarcated from the body of the valve than the posterior ear. Ears continuous with the hinge-line, with a straight upper margin in the right valve, but the anterior ear raised in the left valve so that its antero-superior angle is elevated, and the upper border of the valve is formed by two lines, which are inclined at an angle. The umbones small, flattened, triangular, and pointed, central.

Interior.—The internal surface is smooth. The adductor muscle-scar is shallow and round, placed high up in the valve and posterior to the middle line. The

hinge-plate consists of a horizontal cavity on each side of a central, small cartilage pit. Extending obliquely on either side of this cartilage pit are two ridges which end abruptly, having in the left valve a hollow internal to them, and probably corresponding to hinge-teeth. Still lower an oblique ridge separates, both in front and behind, the slightly hollow flange from the concave body of the valve.

Exterior.—The surface is almost smooth, but the microscope shows close, fine, concentric lines of growth. When the upper layer of shell is removed the valve appears to be covered by closely set, parallel, zigzag markings.

Dimensions.—Pl. XVIII, fig. 24, measures—

Antero-posteriorly	41 mm.
Dorso-ventrally	34 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Park Hill, and Thorpe Cloud, Derbyshire; Hill Bolton, Yorkshire; Poolvash, Isle of Man. Underset Limestone of Lunds Fell and Goodham Gill; below Hardraw Scar Limestone, Mill Gill, and in Swaledale, Yorkshire. Scotland: common in the Upper Limestone and the Lower Limestone series of the East and West of Scotland; Ferniehill, Gilmerton, near Edinburgh. Ireland: Yellow Sandstone of Bruckless; the Carboniferous Limestone of Little Island and Ballyrichards, co. Cork; Howth, co. Dublin; Rathkeale, co. Limerick.

Observations.—*Syncyclonema Sowerbyi* has been well studied by R. Etheridge, jun., who has made out all the important features of the valve. He at once recognised the importance of removing the shell from the genus *Pecten*, and at first referred it provisionally to *Amusium*, afterwards to *Entolium*. I am not certain whether both ears of the left valve are always raised, the posterior appearing often straight, but it may have broken off at the transverse cartilage groove, a weak spot. On the other hand, the ears of the right valve are never raised, a necessary condition to permit of the opening of the valves. I am inclined to think that the valves gaped at the sides, and that the curious flange-like processes in front and behind had some connection with this arrangement.

The shells of *S. Sowerbyi* show considerable variation, both in size and contour, some being much more orbicular than the type, which is preserved in the Griffith Collection in the Museum of Science and Art, Dublin (Pl. XVIII, fig. 26). This specimen shows faint, irregular, oblique colour-bands not indicated in the figure, and is imperfect.

The specimen figured as *Entolium Sowerbyi* by de Koninck in 1885 is evidently wrongly referred to this species. The figure shows none of the peculiar characters of the genus.

There is no doubt that the Russian shell, *P. Valdaicus*, is identical with

S. Sowerbyi, and its name must be placed as a synonym. I am not persuaded of the specific value of *S. Witryi*, de Koninck.

S. Sowerbyi seems to have a very wide horizontal and vertical distribution.

A specimen in the Leckenby Collection, Woodwardian Museum, No. 123 (Pl. XVIII, fig. 21), locality unfortunately unknown, shows a curious system of colour-bands arranged in slightly undulating, concentric lines, which start from the anterior margin, pass obliquely upwards to the centre of the valve, and then descend again to the posterior margin, the angle formed by the two limbs being very wide. De Koninck has described a somewhat similar form of marking, forming a species, *Entolium coloratum*, on this single character. The arrangement of the colour-bands differs in his specimen, being less regular. I doubt if the shape of his figure is correct; probably it is incomplete, there being no lateral flanges, and I think it probable that this character is a generic one.

SYNCYCLONEMA CARBONIFERUM, sp. nov. Plate XIX, figs. 3—6.

Specific Characters.—Shell small, obovate, expanded, very slightly convex; more so near the umbo. Margins of valve small, the anterior the larger. Hinge-line narrow. Ears triangular and raised so that their upper margins meet at the umbo at an obtuse angle, the anterior a little larger and deeper than the left. Umbones small, pointed, swollen, not elevated. Shell very thin.

Interior.—As in *S. Sowerbyi*.

Exterior.—The surface is ornamented with very fine, close, concentric ribs, only visible under the microscope. Ears smooth.

Dimensions.—Pl. XIX, fig. 5, a right valve, measures—

Antero-posteriorly	11 mm.
Dorso-ventrally	15 mm.

Locality.—England: the Marine Band above the Gin Mine Coal, Nettlebank Sinking, Smalthorne, North Staffordshire Coalfield.

Observations.—This little shell occurs plentifully in a bed of grey shale with calcareous bullions at the horizon and locality mentioned above. The Gin Mine Coal is high up in the Coal Measures, and occurs about 430 yards below the Bassy Mine Ironstone, which is taken as the base of the Upper Coal Measures. This bed was recognised by Mr. Ward so long ago as 1865, while a sinking was going on at the Speedwell Colliery, Longton, and it was not until March, 1903, when Mr. Stobbs, mining lecturer under the Staffordshire County Council, noticed marine shells in the spoil-heap from a sinking at Nettlebank, that this marine bed was noticed again. The bed is of great importance, evidently, as a guide to the coal immediately below it, and the value of fossil evidence in mining is demonstrated.

The following list of the fossils found with *S. carboniferum* will be of interest :

BRACHIOPODA :

Athyris ambigua.
Chonetes Lognessiana.
Discina nitida.
Lingula mytiloides.
Orthis resupinata?
Productus semireticulatus.

LAMELLIBRANCHIATA :

Pseudamusium fibrillosum.
Pterinopecten papyraceus.
Posidoniella, sp. nov.
P. lævis.
Syncyclonema carboniferum.
Otenodonta lævirostris.
Nucula gibbosa.
Nuculana Sharmani.
N. acuta.
Schizodus antiquus.
Solenomya primæva.

CEPHALOPODA :

Gastrioceras carbonarium.
Glyphioceras diadema.
Dimorphoceras Gilbertsoni.
Ephippioceras bilobatum.
Pleuronantulus armatus.
Stroboceras sulcatum?
Orthoceras, sp.
O. sulcatum?

GASTEROPODA :

Lozonema, sp.
Macrocheilina, sp.
Raphistoma junior.
 cf. *Turbonellina formosa*.
 cf. *Bellerophon* (*Euphemus*) *Urei*.

ECHINODERMATA :

Archæocidaris (spines and plates).
 Crinoid ossicles.

PISCES :

Listracanthus, *Edestus*, etc.

Many of these species are dwarfed.

S. carboniferum is much narrower than *S. Sowerbyi*, and I think quite a distinct species, and not merely dwarfed. I have been able to see the interior, which in every detail is similar to that of *S. Sowerbyi*, but the valve is markedly ornamented with fine, close, concentric lines.

Genus AMUSIUM, Bolten (ex Klein).

AMUSIUM, Bolten, 1798. Mus. Bolten, pt. 2, p. 165.

Generic Characters.—Shell ovato-triangular, with broad anterior and posterior flanges, flattened. Umbones small. Ears small, triangular, elevated.

Interior.—Marked with broad radiating sulci.

Exterior.—The shell is ornamented with narrow, regular, concentric lines, so fine in some shells as to be almost smooth; occasionally broad, radiating, almost obsolete ribs are seen.

Distribution.—Carboniferous to Recent.

Observations.—Hitherto Carboniferous shells, which had been referred to *Amusium* by McCoy, with a query by R. Etheridge, jun., have been those which possess smooth, non-ribbed, internal surfaces; and, until the present, no species with this character have been recognised from Carboniferous rocks. It is

now known that at least three species have well-marked internal ribs, and therefore they are referred to *Amusium*. It is unnecessary to discuss the question of the relation of this genus to *Synceylonema*, to which it is so closely allied in shape and structure, as this has been fully done in my observations on that genus, p. 116.

AMUSIUM CONCENTRICUM, sp. nov. Plate XXI, figs. 7—11.

ENTOLIUM SOWERBYI, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 241, pl. xxxiii, figs. 5, 6.

AVICULOPECTEN? PROTEUS, *de Koninck*, 1885. Ibid., p. 239, pl. xxxiii, figs. 3, 4; pl. xxxix, fig. 12; and pl. xl, figs. 10—13, 16—20.

Specific Characters.—Shell small, ovate from above downwards. The central part of the valve narrow, triangular, and only moderately convex, separated by broad oblique grooves from an anterior and posterior broad flange-like process. The margin regularly rounded in the greater part of its extent, when it becomes deflected both in front and behind towards the middle line, forming an obtuse angle. The hinge-line short and straight, or angular, the ears very small, the posterior the longer and larger. The umbones small, pointed, and central.

Interior.—The internal surface is ribbed.

Exterior.—The surface is ornamented with regular, fine, concentric lines of growth, through which are seen obscure, almost obsolete, broad, widely separated, radiating ribs.

Localities.—England: the Carboniferous Limestone of Thorpe Cloud, Park Hill, and Castleton, Derbyshire; Hill Bolton, Yorkshire; above the Main Limestone, Nine Standards Rigg, Westmoreland. Ireland: the Carboniferous Limestone of Little Island, co. Cork; Lisbellaw, co. Fermanagh; Croag, co. Limerick; St. Doulaghs, co. Dublin.

Dimensions.—Pl. XXI, fig. 7, measures—

Antero-posteriorly	.	.	.	28 mm.
Dorso-ventrally	.	.	.	34 mm.

Observations.—This little shell is not at all rare in the upper beds of the Carboniferous Limestone of Derbyshire. It has probably always been regarded as the young of *S. Sowerbyi*; indeed, I have no doubt that *de Koninck* figured and described a specimen under this name. A reference to his figure (*loc. cit.*) will show that his shell had radiating ribs and sulci, a character which at once separates *A. concentricum* from that shell. *A. concentricum* is much narrower than *S. Sowerbyi*, and has the concentric markings well developed, the latter shell being almost smooth and also much larger and suborbicular.

AMUSIUM TENUE, *de Koninck*, sp., 1885. Plate XXI, figs. 4—6.

ENTOLIUM TENUE, *de Koninck*, 1885. Ann. Mus. Roy. d'Hist. Nat. Belg., tom. xi, p. 242, pl. xxxii, fig. 18.

Specific Characters.—Shell below medium size, transversely oval, equilateral, feebly convex, the contour of the valve regularly curved. The hinge-line short and straight. The umbones central, small, pointed. The right valve with the ears not raised above the hinge-line, the anterior narrower and slightly longer than the posterior ear, and more definitely marked off from the valve by an oblique linear groove than the posterior ear. The left valve with the ears raised above the hinge-line. The central triangular portion of the body of the valve not well defined from the flange-like, expanded anterior and posterior borders.

Interior.—The internal surface is marked by distant, radiating, shallow grooves.

Exterior.—The surface of the valves is almost smooth, but in the left valve concentric striae and lines of growth are seen under the microscope. The decorticated shell shows zigzag markings.

Dimensions.—Pl. XXI, fig. 6, a left valve, measures—

Antero-posteriorly	.	.	.	.	35 mm.
Dorso-ventrally	.	.	.	.	31 mm.

Localities.—England: a specimen in the York Museum is labelled Northumberland. Scotland: Lower Limestone series at Kirktonholm, East Kilbride.

Observations.—I have referred four specimens from the above locality, in the collection of Mr. J. Neilson, to *de Koninck*'s species, on account of their characteristic shape.

Amusium tenue is much more transverse and regularly oval than *Synacyclonema Sowerbyi*, to which species the specimens in question have been hitherto referred. The valves are more regularly convex, especially that of the right side. The right valve (Pl. XXI, fig. 5) shows well-marked radiating ridges through the thin shell, and therefore the species belongs to the genus *Amusium*.

AMUSIUM PLANICOSTATUM, *McCoy*, sp., 1844. Plate XXI, figs. 1—3.

PECTEN PLANICOSTATUS, *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 98, pl. xiv, fig. 6.

Specific Characters.—Shell of medium size, transversely broadly oval, the left valve only very moderately convex, the right still less so, with the anterior and

posterior margins flattened. The hinge-line short and straight. The inferior margin broad and convex, meeting the slightly convex anterior and posterior margins at a rounded, obtuse angle. The ears very small and not raised; the umbones small, pointed, central, that of the left valve the more convex.

Interior.—The internal surface is crossed by well-marked, broad, radiating grooves and ribs. Pallial line remote from the margin.

Exterior.—The surface is marked by broad radiating ribs and sulci, the ribs being about twice the breadth of the grooves. The ribs often appear subdivided. They are absent for a small space near the posterior border, and are almost obsolete in front. The ribs and sulci are crossed by very close, fine, concentric lines of growth.

Dimensions.—Pl. XXI, fig. 3, a left valve, measures—

Antero-posteriorly	57 mm.
Dorso-ventrally	45 mm.
Depth of left valve about	6 mm.

Locality.—Ireland: Carboniferous Limestone, Cork and Little Island, co. Cork.

Observations.—This species was founded on specimens from Little Island, co. Cork, two large examples being in the collection of Mr. Joseph Wright, of Belfast (Pl. XXI, figs. 1 and 3). Fig. 1 represents a right valve with a portion of the test preserved, showing the general contour of the valve and its anterior ear. Fig. 3 represents a cast of the left valve, a little incomplete at the hinge-line. In this species the broad radiating ribs are present on the surface, and by this character the species is easily identified.

McCoy's type-specimen is preserved in the Griffith Collection of the Museum of Science and Art, Dublin. It is a left valve (Pl. XXI, fig. 2), not quite complete, and was very badly represented by the inaccurate figure in McCoy's work. The hinge-line and general obliquity of the shell are inventions of the artist, and unfortunately the description seems to have been drawn up from the figure rather than from the specimen. McCoy doubted whether he was correct in referring this shell to *Pecten*, I think on good grounds, though I do not consider that the shell has any close relation to *Lima*. He says, "I have much doubt whether this shell really belongs to the genus *Pecten*; it is at least an aberrant type, and if placed in this genus it leads to *Lima*, and if placed in *Lima* it leads back to the present genus."

PLATE VII.

Fig. 1.—*Eumicrotis hemisphæricus*. The left valve of a bivalved example. Fig. 1 *a*. The right valve of the same shell with the anterior ear broken away. Fig. 1 *b*. The same specimen viewed from above, showing that the valves have slipped on each other. From the Carboniferous Limestone of Hill Bolton, Craven. My Collection. (Page 45.)

Fig. 2.—*Eumicrotis hemisphæricus*. A left valve, the type of Phillips's *Pecten hemisphæricus*. In the Gilbertson Collection, Natural History Museum, South Kensington. (Page 46.)

Fig. 3.—*Eumicrotis hemisphæricus*. A left valve. From the Carboniferous Limestone of Park Hill. My Collection. (Page 45.)

Fig. 4.—*Eumicrotis hemisphæricus*. A right valve. From the Carboniferous Limestone of Poolvash, Isle of Man. My Collection. (Page 45.)

Fig. 5.—*Eumicrotis hemisphæricus*. A left valve to show the sulcus in the cast, between the umbo and the anterior ear. From the Carboniferous Limestone of Castleton. My Collection. (Page 45.)

Fig. 6.—*Eumicrotis hemisphæricus*. A left valve. Same locality and Collection. (Page 45.)

Fig. 7.—*Pterinopecten papyraceus*. A left valve. Roof of the Hard Coal, Halifax. My Collection. (Page 51.)

Fig. 8.—*Pterinopecten papyraceus*. A right valve, uncrushed. From a bullion in the Pendleside series of Horsebridge Clough. My Collection. (Page 51.)

Fig. 9.—*Pterinopecten papyraceus*. A right valve, with well-preserved anterior ear. From the roof of the Hard Coal, Halifax. My Collection. (Page 51.)

Fig. 10.—*Pterinopecten papyraceus*. An uncrushed left valve. Same locality and Collection. (Page 51.)

Fig. 11.—*Pterinopecten papyraceus*. A left valve, flattened by pressure. Above the Hard Coal, Halifax. My Collection. (Page 51.)

Fig. 12.—*Pterinopecten papyraceus*. Right and left valves. From shales below the Third Grit, Wadsworth Moor. My Collection. (Page 51.)

Fig. 13.—*Pterinopecten papyraceus*. A left valve. From the Lower Coal Measures of Southowram. My Collection. (Page 51.)

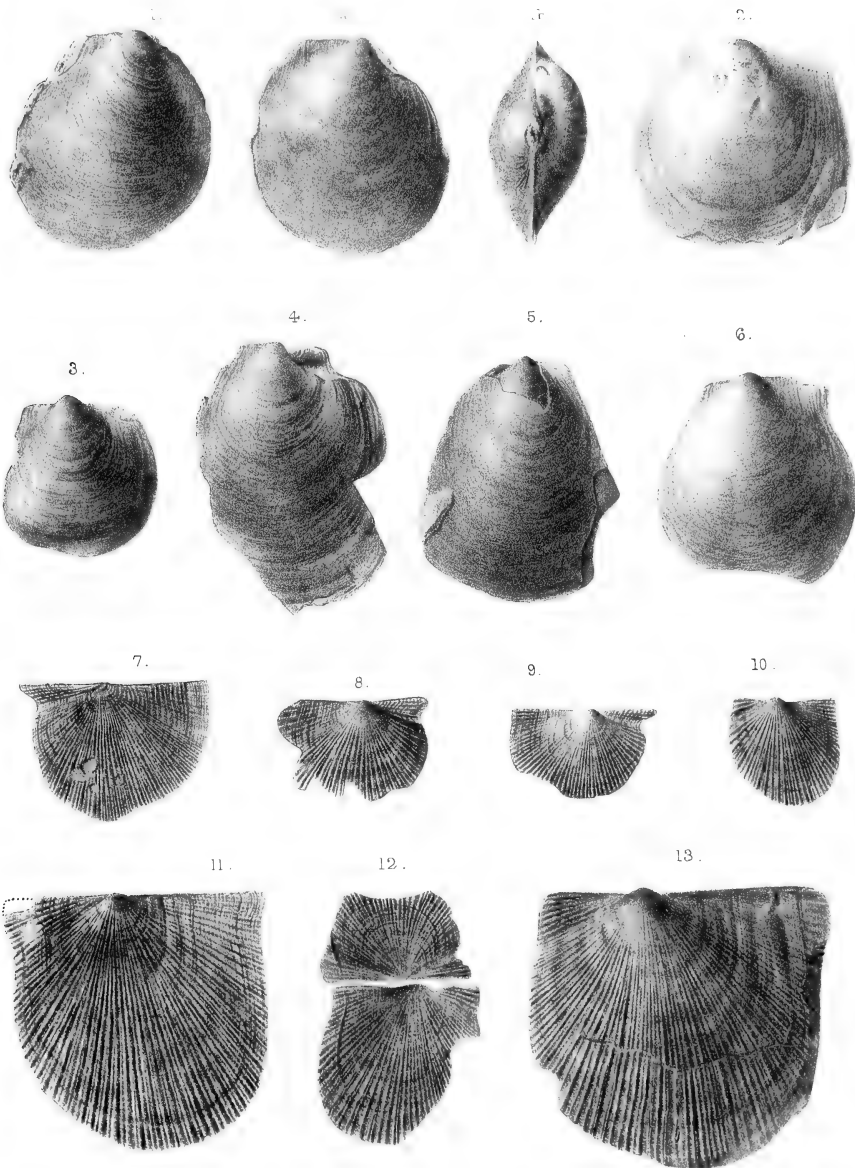


PLATE VIII.

Fig. 1.—*Pterinopecten rigidus*. A left valve. From the Carboniferous Limestone, Drumkeeran, co. Fermanagh. In the Collection of the Geological Survey of Ireland. (Page 61.)

Fig. 2.—*Pterinopecten rigidus*. A left valve. From Millicent, Clane. In the Collection of the Woodwardian Museum (No. 146), Cambridge. (Page 60.)

Fig. 3.—*Pterinopecten rigidus*. The shell figured by Portlock as *Orthis umbraculum*. A left valve. From co. Fermanagh. In the Museum of the Geological Survey, Jermyn Street. (Page 61.)

Fig. 3 a.—*Pterinopecten rigidus*. The hinge-plate of Fig. 3.

Fig. 4.—*Pterinopecten Dumontianus*. A left valve. From the Carboniferous Limestone of Castleton, Derbyshire. My Collection. (Page 65.)

Fig. 5.—*Pterinopecten Dumontianus*. A left valve. From Poolvash, Isle of Man. My Collection. (Page 66.)

Fig. 5 a.—*Pterinopecten Dumontianus*. The right valve of Fig. 5.

Fig. 6.—*Pterinopecten Dumontianus*. A well-preserved left valve. From the Carboniferous Limestone of Craven. In the York Museum. (Page 65.)

Fig. 7.—*Pterinopecten Dumontianus*. A left valve, showing rather coarser ribs. From the Carboniferous Limestone of Castleton. My Collection. (Page 65.)

Fig. 8.—*Pterinopecten Dumontianus*. A full-grown left valve. From the Carboniferous Limestone of Settle. In the Collection of the Woodwardian Museum (No. 152). (Page 66.)

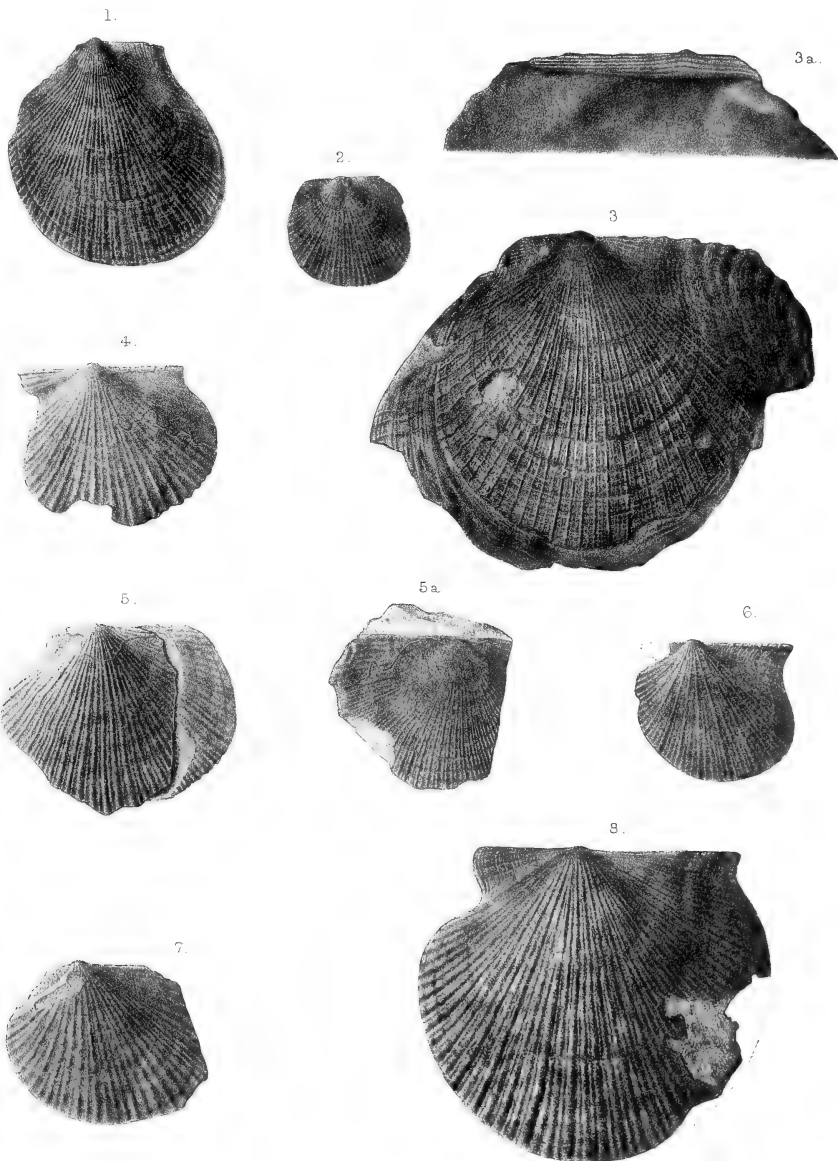


PLATE IX.

Fig. 1.—*Limatulina scotica*. Portion of a left valve, showing the posterior ear. Muirfoot Burn, New Cumnock, Ayrshire. My Collection. (Page 36.)

Fig. 2.—*Limatulina scotica*. The left valve. Same locality. In the Collection of Mr. J. Smith, of Kilwinning. (Page 36.)

Fig. 3.—*Limatulina scotica*. The right valve of the last figure, showing the overlapping of the left valve and the flat right valve. Same locality and Collection. (Page 36.)

Figs. 4, 5.—*Limatulina scotica*. A fairly perfect specimen, Fig. 4 showing the right and Fig. 5 the left valve. Same locality. My Collection. (Page 36.)

Fig. 6.—*Pterinopecten concavus*. A left valve, the re-described type of McCoy's species. From Lowick, Northumberland. In the Collection of the Woodwardian Museum, Cambridge. (Page 54.)

Fig. 7.—*Pterinopecten concavus*. Portion of a right valve. From the Carboniferous Limestone of Lowick, Northumberland. Same Collection. (Page 55.)

Fig. 8.—*Pterinopecten tessellatus*. A left valve. From the Carboniferous Limestone of Little Island, co. Cork. In the Collection of Mr. J. Wright. (Page 63.)

Fig. 9.—*Pterinopecten tessellatus*. A right valve. Same locality and Collection. (Page 64.)

Fig. 10.—*Pterinopecten tessellatus*. A left valve, adult size. Phillips's type, preserved in the Gilbertson Collection, Natural History Museum, South Kensington. (Page 64.)

Fig. 11.—*Pterinopecten tessellatus*. A left valve, showing the posterior ear. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 63.)

Fig. 12.—*Pterinopecten radiatus*. A left valve. From the Carboniferous Limestone of Thorpe Cloud. My Collection. (Page 55.)

Fig. 13.—*Pterinopecten radiatus*. A left valve with coarser ribs. From the Carboniferous Limestone of Castleton. My Collection. (Page 56.)

Fig. 14.—*Pterinopecten radiatus*. A full-grown left valve. From Ireland. In the York Museum. (Page 56.)

Fig. 15.—*Pterinopecten radiatus*. An almost perfect left valve. From the Carboniferous Limestone of co. Dublin. In the Collection of Mr. J. Wright. (Page 55.)

Fig. 16.—*Pterinopecten radiatus*. Phillips's type, in the Gilbertson Collection, Natural History Museum, South Kensington. (Page 56.)

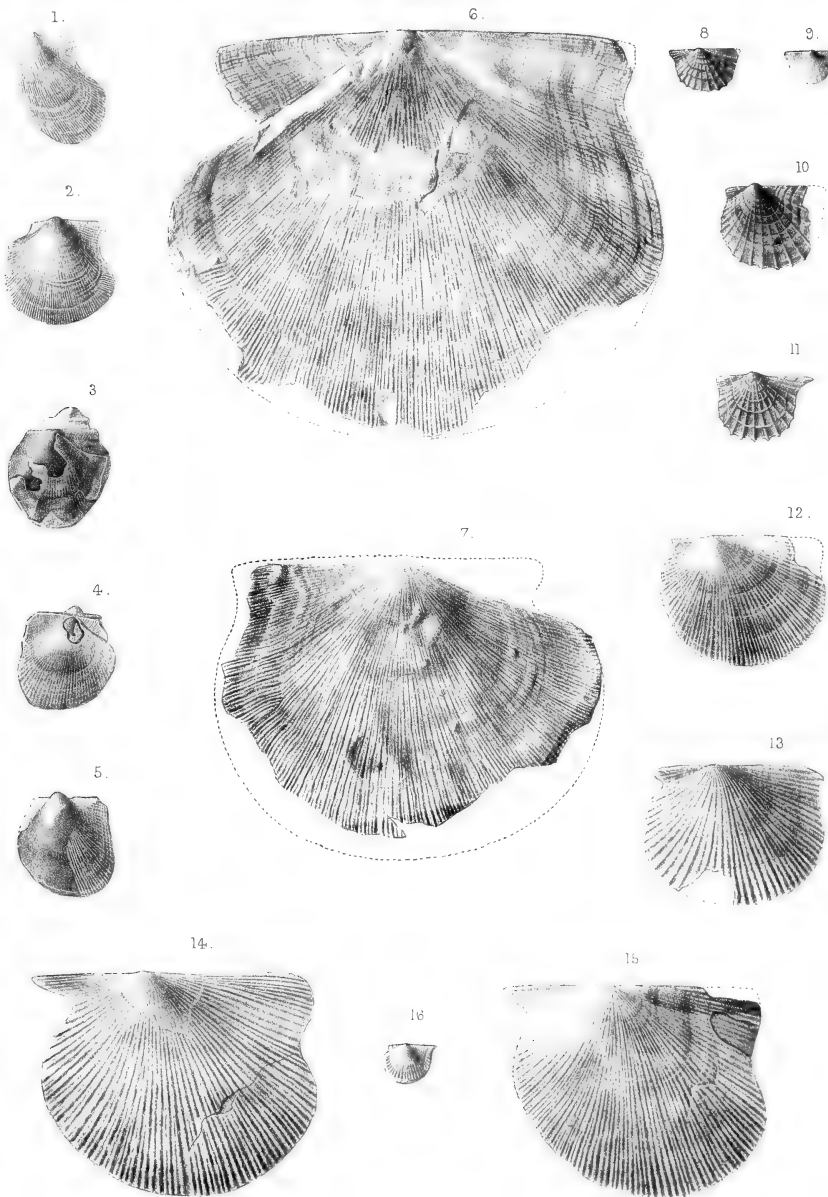


PLATE X.

Fig. 1.—*Pterinopecten granosus*. A left valve. From the Carboniferous Limestone of Kildare. York Museum. (Page 57.)

Fig. 2.—*Pterinopecten granosus*. A left valve. From the Carboniferous Limestone of Clitheroe. In the Collection of Mr. R. Law. (Page 58.)

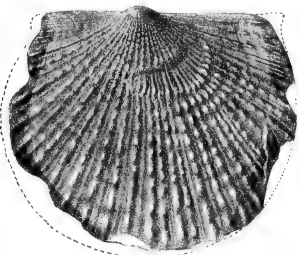
Fig. 3.—*Pterinopecten granosus*. The left valve of a bivalved example, showing (Fig. 3 *a*) the differences in the contour of each valve, and (Fig. 3 *b*) the flattened right valve. From the Carboniferous Limestone of Castleton. My Collection. (Page 58.)

Fig. 4.—*Pterinopecten eximius*. A portion of the left valve. From the Carboniferous Limestone of Derbyshire. In the Woodwardian Museum, Cambridge. (Page 59.)

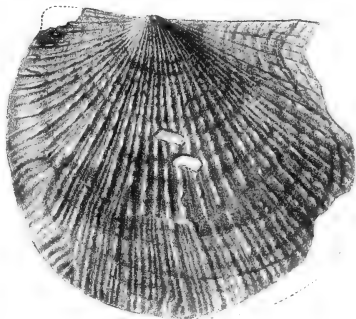
Fig. 5.—*Pterinopecten eximius*. The greater portion of a right valve. From Kniveton Quarry, Derbyshire. My Collection. (Page 59.)

Fig. 6.—*Pterinopecten granosus*. Portion of a left valve. Sowerby's type. Preserved in the Sowerby Collection, Natural History Museum, South Kensington. (Page 58.)

1.



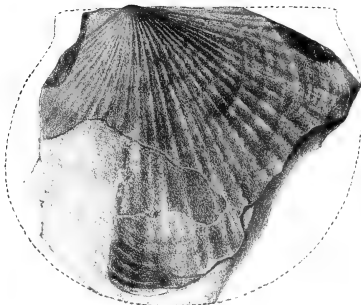
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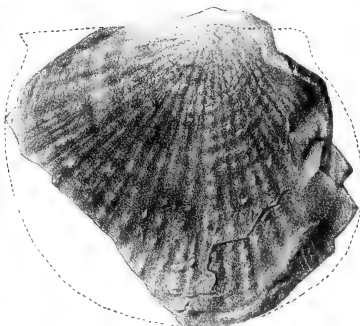
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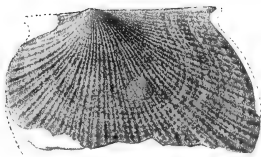
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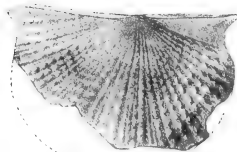
3b.



4



5



6



PLATE XI.

Fig. 1.—*Streblopteria lævigata*. A left valve from Caherass, co. Limerick. In the Collection of the Geological Survey of Ireland. (Page 48.)

Fig. 2.—*Streblopteria lævigata*. A left valve, showing the anterior ear. Same locality and Collection. (Page 48.)

Fig. 3.—*Streblopteria lævigata*. The type specimen, from Millicent, Kildare. In the Griffith Collection, Science and Art Museum, Dublin. (Page 48.)

Fig. 4.—*Streblopteria lævigata*. A right valve from Lowick. In the Collection of the Woodwardian Museum, Cambridge. (Page 48.)

Fig. 5.—*Streblopteria lævigata*. Portion of a right valve, showing the anterior ear. From Cloghran, co. Dublin. My Collection. (Page 48.)

Fig. 6.—*Streblopteria lævigata*. The left valve of Fig. 5, showing colour bands. The anterior ear is broken off. (Page 48.)

Fig. 7.—*Streblopteria lævigata*. A right valve. From Doohylebeg, co. Limerick. In the Collection of the Geological Survey of Ireland. (Page 48.)

Fig. 8.—*Eumicrotis ovalis*. A left valve. From co. Cork. In the York Museum. (Page 46.)

Fig. 9.—*Eumicrotis ovalis*. A left valve. From Settle. In the Woodwardian Museum, Cambridge. (Page 46.)

Fig. 10.—*Streblopteria ornata*. Right and left valves. From River Gryfe, near Crosslea Mill, Houston. In the Collection of the Geological Survey of Scotland. (Page 50.)

Fig. 11.—*Streblopteria ornata*. A left valve. From Waygateshaw Limestone Pit, Carlisle. Same Collection. (Page 50.)

Fig. 12.—*Streblopteria ornata*. The cast of a right valve. From same Collection. (Page 50.)

Fig. 13.—*Pterinopecten eximius*. A right valve, with portion of the left valve showing below the lower margin. From St. Doulaghs, co. Dublin. Collection of the Woodwardian Museum, Cambridge. (Page 60.)

Fig. 14.—*Pterinopecten eximius*. A left valve, somewhat sheared. From the Lower Limestone Shales, Clonakilty, co. Cork. Collection of the Geological Survey of Ireland. (Page 60.)

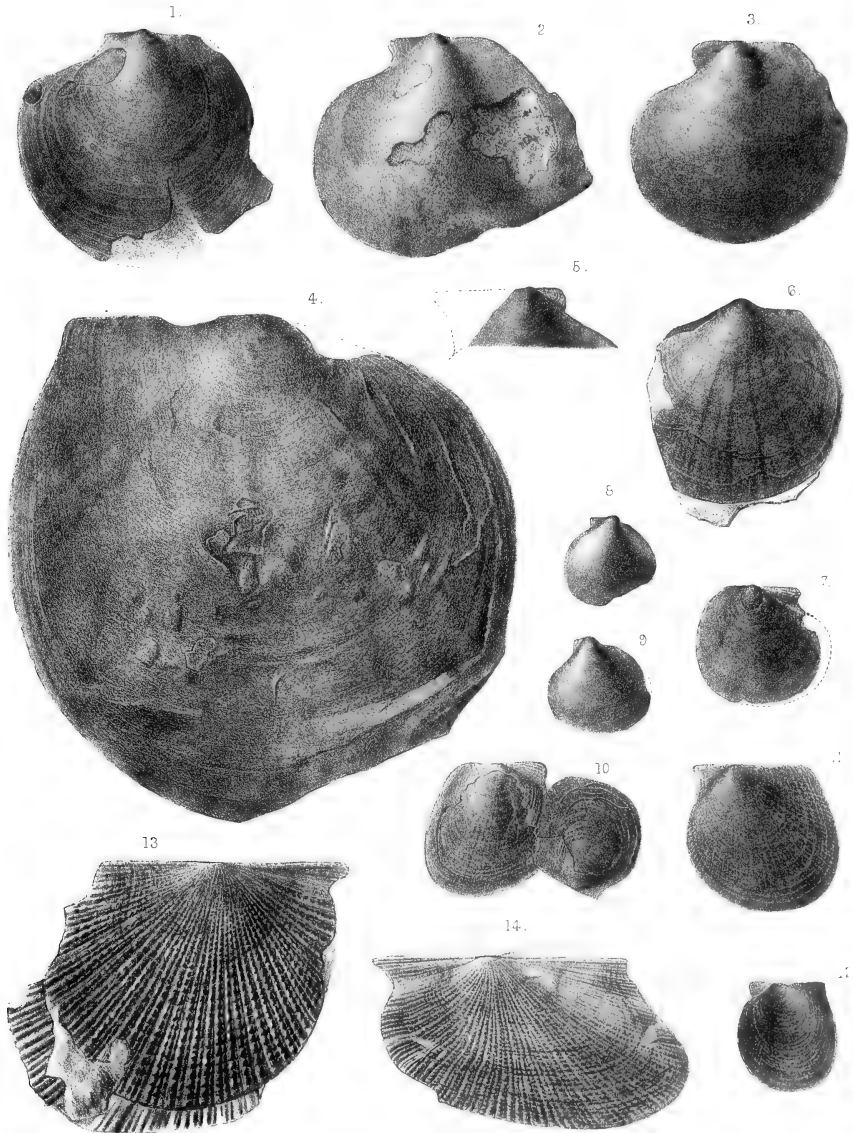


PLATE XII.

Fig. 1.—*Aviculopecten tabulatus*. A left valve, presumably Mc'Coy's type of the species. From Derbyshire. In the Woodwardian Collection, Cambridge. (Page 68.)

Fig. 2.—*Aviculopecten tabulatus*. A right valve. From Park Hill. In the Collection of the Geological Survey, Jermyn Street. (Page 68.) *

Fig. 3.—*Aviculopecten tabulatus*. A left valve. From Hill Bolton, Yorkshire. My Collection. (Page 68.)

Fig. 4.—*Aviculopecten tabulatus*. The impression of a right valve, showing the large posterior ear. From Poolvash, Isle of Man. In the Collection of Mr. R. Law. (Page 67.)

Fig. 5.—*Aviculopecten plicatus*. A right valve. From the Carboniferous Limestone of Ireland. In the Woodwardian Museum, Cambridge. (Page 73.)

Fig. 6.—*Aviculopecten plicatus*. The left valve. The type of Sowerby's *Pecten plicatus*. Preserved in the Sowerby Collection, Natural History Museum, South Kensington. (Page 74.)

Fig. 7.—*Aviculopecten Eskdalensis*.—A young bivalved example. From the Calciferous Sandstone series, River Esk, Glencartholm. In the Collection of the Geological Survey of Scotland. (Page 74.)

Fig. 8.—*Aviculopecten plicatus*. A right valve. From the Limestone of Rathkeale, co. Limerick. In the Collection of Mr. J. Wright. (Page 74.)

Fig. 9.—*Aviculopecten plicatus*. A left valve, from the Limestone of co. Dublin, showing the ribs to be crenulated. Same Collection. (Page 73.)

Fig. 10.—*Aviculopecten Eskdalensis*. Right and left valves. Calciferous Sandstone series, River Esk. (Page 75.)

Fig. 11.—*Aviculopecten Eskdalensis*. Right and left valves, with rather coarser ribs. Same locality and Collection. (Page 74.)

Fig. 12.—*Aviculopecten fimbriatus*. The cast of a left valve, with a small portion of the last preserved, showing the ornament. From Castleton. My Collection. (Page 93.)

Fig. 13.—*Aviculopecten fimbriatus*. A right valve. In the Collection of the York Museum. From Settle. (Page 93.)

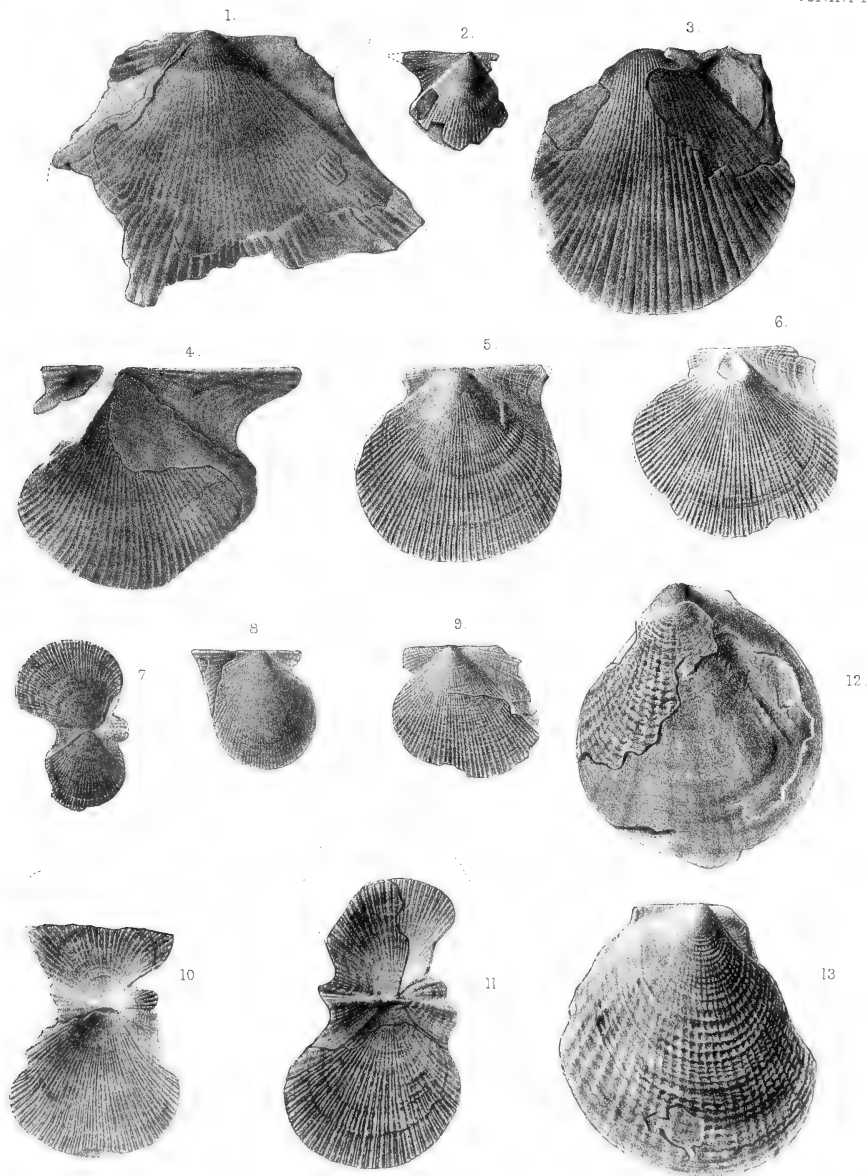


PLATE XIII.

Fig. 1.—*Aviculopecten dissimilis*. The left valve, crushed in but fairly whole. From the Limestone of Corrieburn, Scotland. In the Collection of Mr. James Neilson. (Page 71.)

Figs. 2 and 3.—*Aviculopecten dissimilis*. The right and left valves of a shell from the Lower Limestone series, Beith. Same Collection. (Page 70.)

Fig. 4.—*Aviculopecten dissimilis*. A left valve, the specimen figured as *A. calatus* by McCoy. In the Woodwardian Museum, Cambridge. (Page 70.)

Fig. 5.—*Aviculopecten dissimilis*. A right valve. The type figured by Phillips. Preserved in the Gilbertson Collection, Natural History Museum, South Kensington. (Page 72.)

Fig. 6.—*Aviculopecten dissimilis*. The left valve of young specimen from the Carboniferous Limestone of Llangollen. In the Collection of the Geological Survey, Jermyn Street. (Page 70.)

Fig. 7.—*Aviculopecten dissimilis*. The right valve of a young specimen. From the Carboniferous Limestone of Halkin Mountain, Holywell. Same Collection. (Page 70.)

Fig. 8.—*Aviculopecten dissimilis*. Showing the ears of the right valve. From Glen Hind Og, Dalry. My Collection. (Page 70.)

Fig. 9.—*Aviculopecten semicostatus*. The internal cast of a left valve. The type of Portlock's *Pecten semicostatus*. Preserved in the Collection of the Geological Survey, Jermyn Street. (Page 69.)

Fig. 10.—*Aviculopecten semicostatus*. The specimen figured by Phillips as *Pecten plicatus*, Sow. In the Gilbertson Collection, Natural History Museum, South Kensington. (Page 70.)

Fig. 11.—*Aviculopecten semicostatus*. A cast showing the hinge-plate. From the Carboniferous Limestone of Poolvash, Isle of Man. In the Collection of Mr. R. Law. (Page 70.)

Fig. 12.—*Aviculopecten semicostatus*. A right valve. From the Carboniferous Limestone series of Redesdale. My Collection. (Page 69.)

Fig. 13.—*Aviculopecten semicostatus*. A left valve, showing the posterior ear. Redesdale Ironstone Beds, Redesdale. My Collection. (Page 69.)

Fig. 14.—*Aviculopecten semicostatus*. The type of *A. docens*, McCoy. The cast of a left valve. From Lowick. In the Woodwardian Museum, Cambridge. (Page 70.)

Fig. 15.—*Aviculopecten semicostatus*. A right valve. From the Redesdale Ironstone. My Collection. (Page 69.)

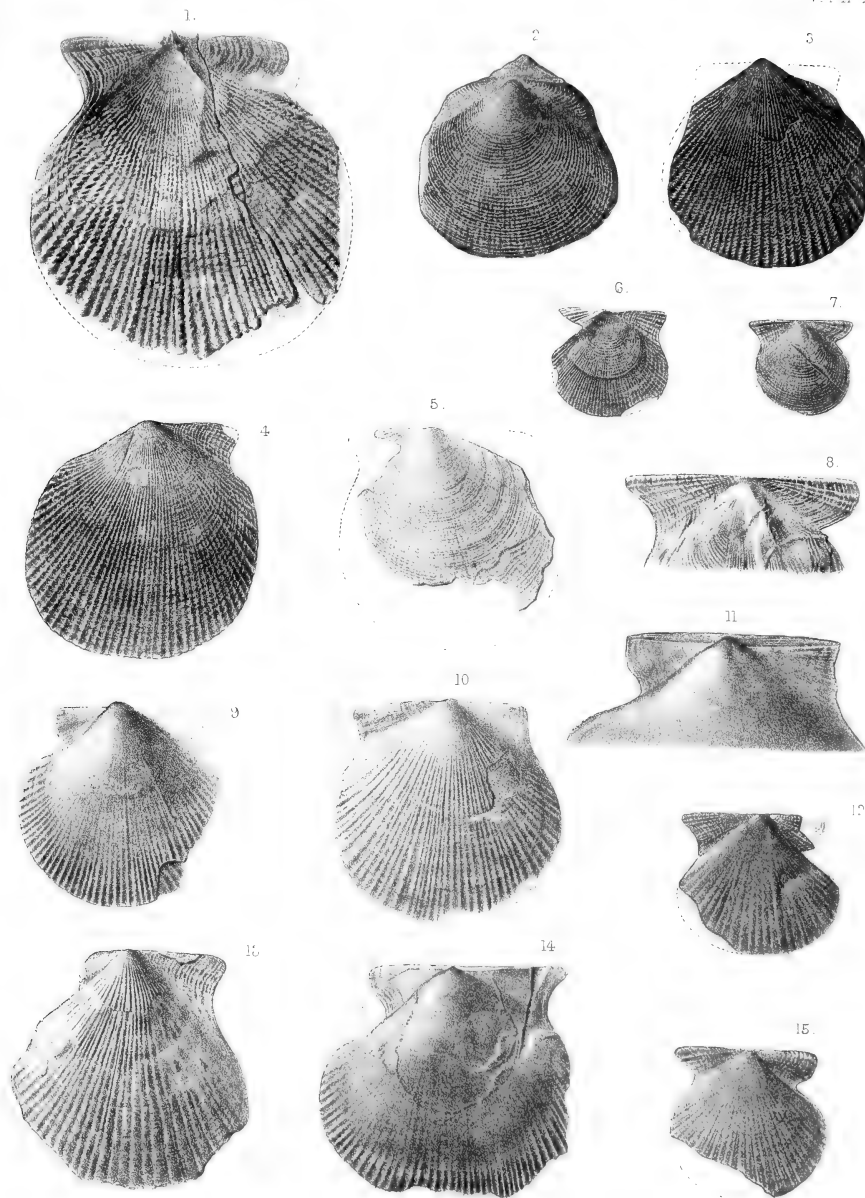


PLATE XIV.

Fig. 1.—*Pterinopecten Dumontianus*. The left valve. In the Manchester Museum, Owens College. (Page 65.)

Fig. 2.—*Pterinopecten Dumontianus*. The right valve of the same shell. (Page 65.)

Fig. 3.—*Aviculopecten Murchisoni*. The type of M'Coy's *Pecten Murchisoni*. A left valve. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 99.)

Fig. 4.—*Aviculopecten Murchisoni*. A left valve, showing the prolongation of the ribs beyond the margin of the valve as spines. From the Carboniferous Limestone of Derbyshire. Manchester Museum, Owens College. (Page 98.)

Fig. 5.—*Aviculopecten Murchisoni*. Part of left valve, showing the rare posterior wing. From Castleton. My Collection. (Page 98.)

Fig. 6.—*Aviculopecten Murchisoni*. A small left valve, without the ears. From Castleton. My Collection. (Page 98.)

Fig. 7.—*Aviculopecten Murchisoni*. The right valve of the same shell. (Page 98.)

Fig. 8.—*Aviculopecten Knockonniensis*. A right valve. From above the Underset Limestone, Farcote Gill, Westmoreland. My Collection. (Page 84.)

Fig. 9.—*Aviculopecten Knockonniensis*. A left valve. From Salton, Scotland. In the Collection of the Geological Survey of Scotland. (Page 84.)

Fig. 10.—*Aviculopecten Knockonniensis*. A right valve. Same locality and Collection. (Page 84.)

Fig. 11.—*Aviculopecten Knockonniensis*. A left valve. From Derbyshire. In the Woodwardian Museum, Cambridge. (Page 84.)

Figs. 12, 13.—*Aviculopecten Knockonniensis*. Two young examples. Underset Limestone, Farcote Gill. My Collection. (Page 84.)

Fig. 14.—*Aviculopecten inequalis*. A specimen showing both valves. From Boness. In the Collection of the Geological Survey of Scotland. (Page 99.)

Fig. 15.—*Aviculopecten inequalis*. The small valve of the same specimen. (Page 99.)

Fig. 16.—*Aviculopecten interstitialis*. A left valve, almost denuded of test. From Castleton, Derbyshire. My Collection. (Page 95.)

Fig. 17.—*Aviculopecten interstitialis*. The right valve of the same specimen. (Page 94.)

Fig. 18.—*Aviculopecten interstitialis*. The left valve, showing the typical ornament. Same locality and Collection. (Page 94.)

Fig. 19.—*Aviculopecten interstitialis*. Phillips's type specimen, and fragment of a left valve. In the Gilbertson Collection, Natural History Museum, South Kensington. (Page 94.)

Figs. 20, 21.—*Aviculopecten interstitialis*. Two left valves. From Wetton and Castleton respectively. My Collection. (Page 94.)

Fig. 22.—*Aviculopecten Ruthveni*. M'Coy's type. Preserved in the Woodwardian Museum, Cambridge. (Page 97.)

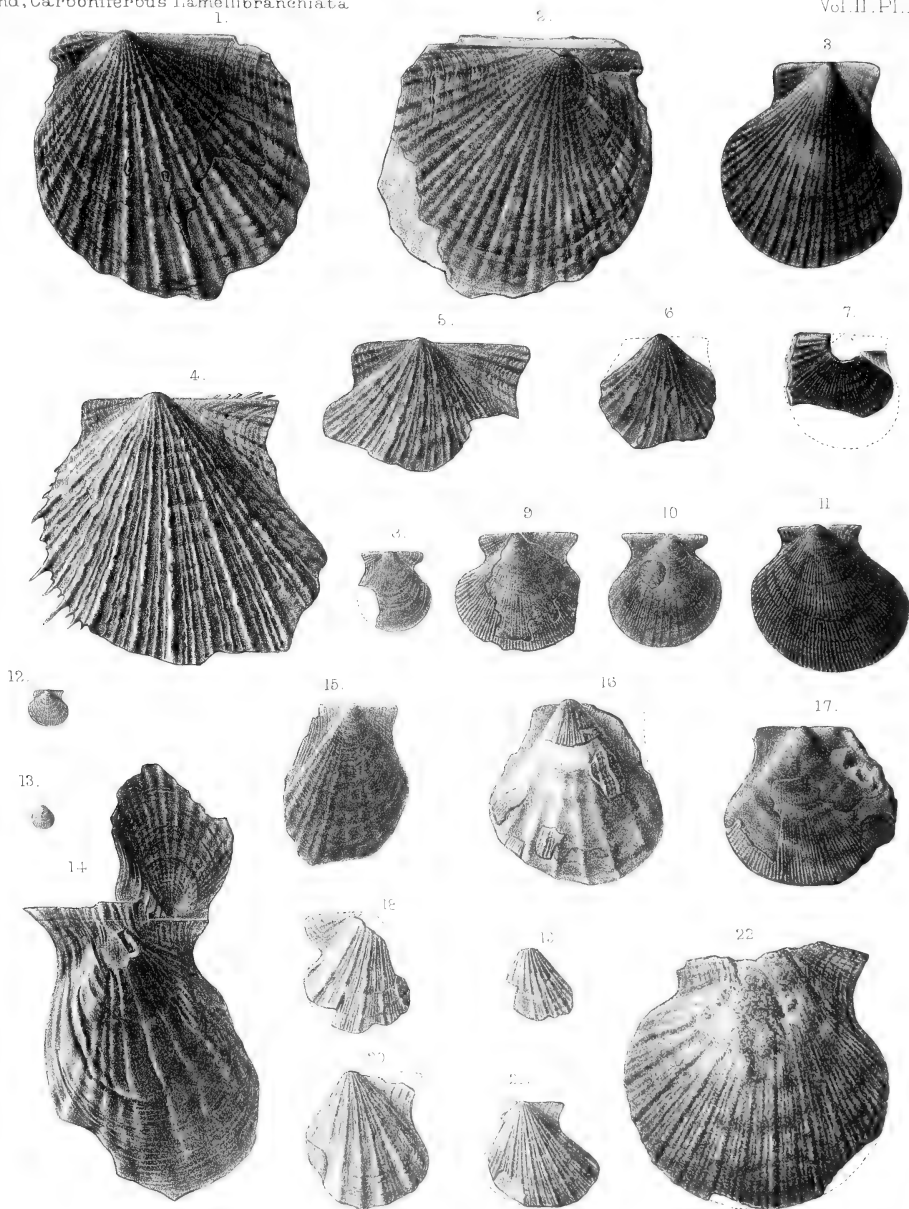


PLATE XV.

Figs. 1, 3.—*Aviculopecten clathratus*. A left valve. From Little Island, Cork. In the Collection of Mr. J. Wright. (Page 82.)

Fig. 2.—*Aviculopecten clathratus*. A left valve. From Castleton, Derbyshire. My Collection. (Page 82.)

Fig. 4.—*Aviculopecten clathratus*. A right valve of a very young specimen. Mr. J. Wright's Collection. (Page 82.)

Fig. 5.—*Aviculopecten clathratus*. A left valve of the above shell. (Page 82.)

Fig. 6.—*Aviculopecten clathratus*. A right valve. Same locality. In the Collection of the Geological Survey of Ireland. (Page 82.)

Fig. 7.—*Aviculopecten clathratus*. The type of M'Coy's *Pecten intercostatus*. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 83.)

Fig. 8.—*Aviculopecten planoclathratus*. A left valve. From Little Island, Cork. In the Collection of Mr. J. Wright. (Page 92.)

Fig. 9.—*Aviculopecten planoclathratus*. A right valve. Same locality and Collection. (Page 92.)

Fig. 10.—*Aviculopecten planoclathratus*. A left valve. From Castleton, Derbyshire. My Collection. (Page 92.)

Fig. 11.—*Aviculopecten planoclathratus*. A left valve. From Poolvash, Isle of Man. My Collection. (Page 92.)

Fig. 12.—*Aviculopecten planoclathratus*. M'Coy's type. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 92.)

Fig. 13.—*Aviculopecten pera*. A right valve. From Narrowdale, Staffordshire. My Collection. (Page 78.)

Fig. 14.—*Aviculopecten pera*. A left valve. From Wetton. In the Collection of the Geological Survey, Jermyn Street. (Page 78.)

Fig. 15.—*Aviculopecten pera*. A left valve. From Narrowdale. My Collection. (Page 78.)

Fig. 16.—*Aviculopecten perradiatus*. A left valve. From Park Hill, Derbyshire. My Collection. (Page 87.)

Fig. 17.—*Aviculopecten perradiatus*. A left valve. From Narrowdale. Museum of the Geological Survey, Jermyn Street. (Page 87.)

Fig. 18.—*Aviculopecten perradiatus*. The cast of a right valve. From Park Hill. My Collection. (Page 87.)

Fig. 19.—*Aviculopecten intermedius*. A left valve. From the Carboniferous Limestone of Hill Bolton. My Collection. (Page 81.)

Fig. 20.—*Aviculopecten intermedius*. A left valve. From Poolvash, Isle of Man. My Collection. (Page 81.)

Fig. 21.—*Crenipecten semicircularis*. A left valve. From Castleton, Derbyshire. In the Collection of Mr. R. Law. (Page 113.)

Fig. 22.—*Crenipecten semicircularis*. A right valve showing the peculiar hinge-plate. Lunedale. My Collection. (Page 113.)

Fig. 23.—*Crenipecten semicircularis*. A right valve. From Derbyshire. Wood Collection, York Museum. (Page 113.)

Fig. 24.—*Aviculopecten intermedius*. A left valve, showing the long posterior ear. From Settle. In the Woodwardian Museum. (Page 81.)

Fig. 25.—*Aviculopecten intermedius*. A specimen from Castleton, which I think may be the adult form. My Collection. (Page 81.)

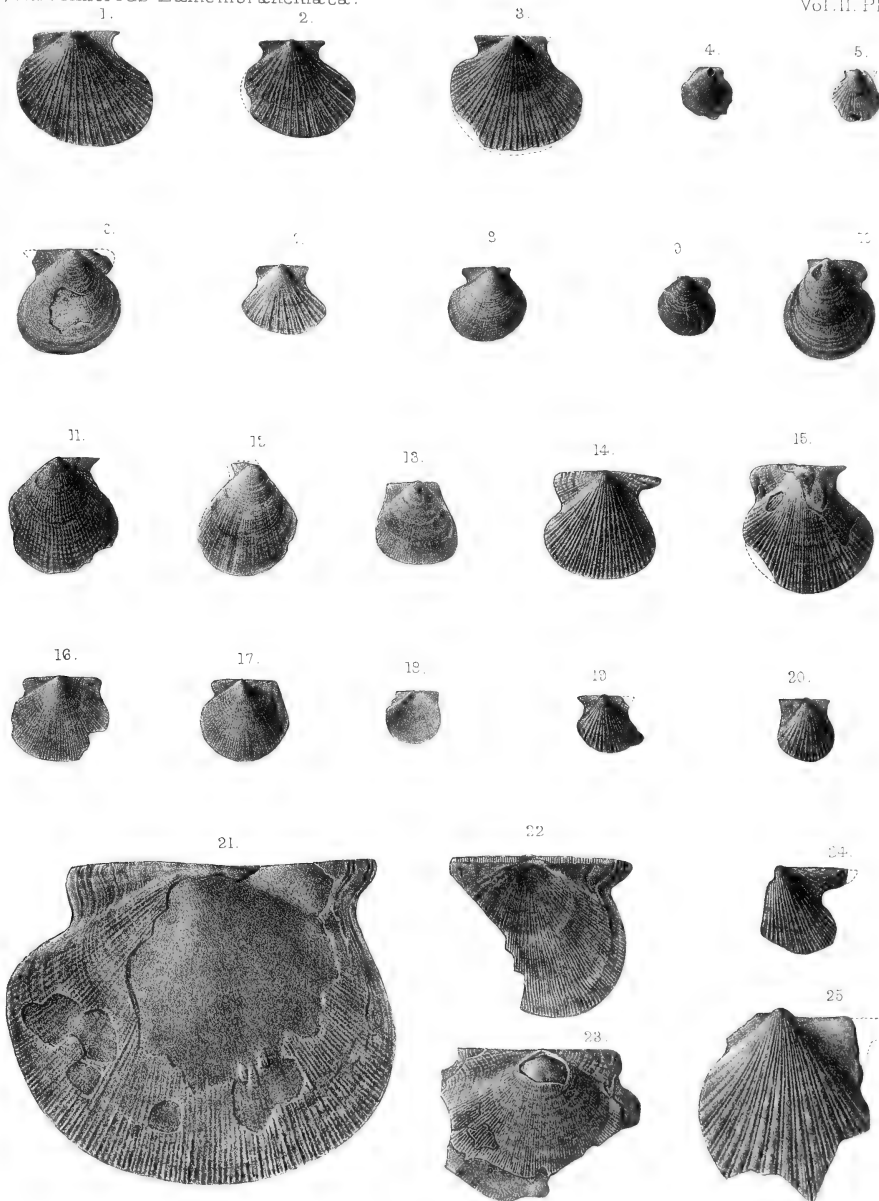




PLATE XVI.

Fig. 1.—*Aviculopecten nobilis*. A left valve. From the Carboniferous Limestone of Settle. Woodwardian Museum, Cambridge. (Page 90.)

Fig. 2.—*Aviculopecten nobilis*. A right valve. Same locality and Collection. (Page 90.)

Fig. 3.—*Aviculopecten nobilis*. A left valve. Same locality and Collection. (Page 90.)

Fig. 4.—*Aviculopecten nobilis*. A left valve. From Settle. Same locality and Collection. (Page 90.)

Figs. 5, 6.—*Aviculopecten nobilis*. Two left valves. Same locality and Collection. (Page 90.)

Fig. 7.—*Aviculopecten stellaris*. A left valve, the type specimen. In the Gilbertson Collection, Natural History Museum, South Kensington. (Page 88.)

Fig. 8.—*Aviculopecten stellaris*. A left valve. From Castleton. My Collection. (Page 88.)

Figs. 9, 10.—*Aviculopecten stellaris*. Left valves. Same locality and Collection. (Page 88.)

Fig. 11.—*Aviculopecten stellaris*. A right valve. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 88.)

Fig. 12.—*Aviculopecten incrassatus*. A left valve. From the Carboniferous Limestone of Cork. Mr. J. Wright's Collection. (Page 89.)

Fig. 13.—*Aviculopecten incrassatus*. A left valve. Same locality and Collection. (Page 89.)

Fig. 14.—*Aviculopecten incrassatus*. A left valve. From Little Island, co. Cork. Same locality and Collection. (Page 89.)

Fig. 15.—*Aviculopecten incrassatus*. The type specimen, a left valve. From Lisnapaste, co. Donegal. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 89.)

Fig. 16.—*Pseudamussium fibrillosum*. A right valve, external cast. Coal Measures, River Tame, Ashton. Probably the type. Museum of the Geological Survey, Jermyn Street. (Page 106.)

Figs. 17—19.—*Pseudamussium fibrillosum*. Three left valves. Same locality and Collection. (Page 106.)

Fig. 20.—*Pseudamussium fibrillosum*. Both valves from Slieve Carna, co. Mayo. In the Collection of the Geological Survey of Ireland. (Page 106.)

Figs. 21, 22.—*Pseudamussium fibrillosum*. Two right valves. From River Ribble, near Little Dinckly Hall. Pendleside Series. My Collection. (Page 106.)

Fig. 23.—*Pseudamussium auriculatum*. A right valve. From Millicent, Kildare. In the Woodwardian Museum, Cambridge. (Page 108.)

Fig. 24.—*Pseudamussium auriculatum*. Distorted by shearing. The type of *Lima levigata*, McCoy. In the Griffith Collection, Science and Art Museum, Dublin. (Page 109.)

Figs. 25, 26.—*Pseudamussium auriculatum*. The left and right valves of a shell. From Knocksouna, co. Limerick. In the Collection of the Geological Survey, Dublin. (Page 108.)

Fig. 27.—*Pseudamussium auriculatum*. A left valve. Same Collection. (Page 108.)

Fig. 28.—*Aviculopecten Sedgwicki*. A left valve. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 101.)

Fig. 29.—*Aviculopecten Sedgwicki*. A left valve. From Narrowdale, Staffordshire. My Collection. (Page 101.)

Figs. 30—32.—*Aviculopecten Sedgwicki*. Three views of a bivalved example showing the flattening of the right valve. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 101.)

Fig. 33.—*Aviculopecten Sedgwicki*. A left valve. Same locality and Collection. (Page 101.)

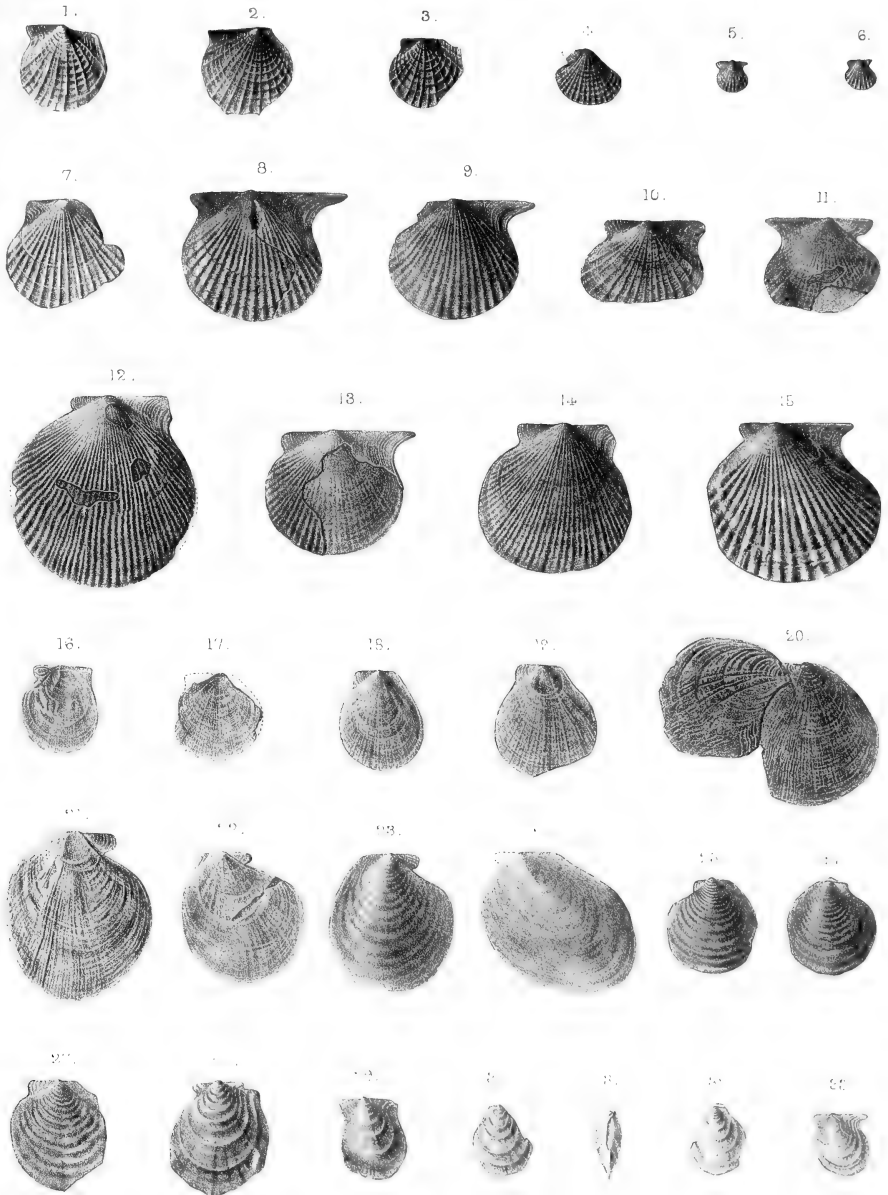


PLATE XVII.

Fig. 1.—*Aviculopecten subconoides*. A right valve. From Knockhill, Fife. Marked as one of R. Etheridge's types. In the Collection of the Geological Survey of Scotland. (Page 77.)

Figs. 2, 3.—*Aviculopecten subconoides*. Two left valves. Also marked as types. Same locality and Collection. (Page 77.)

Fig. 4.—*Aviculopecten subconoides*. A right valve. Same locality. My Collection. (Page 77.)

Fig. 5.—*Aviculopecten subconoides*. A left valve, full size. Same locality and Collection. (Page 77.)

Fig. 6.—*Aviculopecten gentilis*. A left valve. †The type of Sowerby's *Pecten gentilis*. From the Pennystone Ironstone, Coalbrookdale. Preserved in the Natural History Museum, South Kensington. (Page 86.)

Fig. 7.—*Aviculopecten gentilis*. A right valve. From beds below the Third Grit, Congleton Edge, Cheshire. My Collection. (Page 86.)

Figs. 8, 9.—*Aviculopecten gentilis*. Two left valves. Same locality and Collection. (Page 86.)

Fig. 10.—*Aviculopecten gentilis*. A right valve. Same locality and Collection. (Page 86.)

Figs. 11, 12.—*Pseudamysium sublobatum*. Two right valves, showing colour-bands. From Park Hill, Derbyshire. Figured by R. Etheridge, jun. In the Museum of the Geological Survey, Jermyn Street. (Page 110.)

Figs. 13, 14.—*Pseudamysium sublobatum*. Two left valves, showing colour-bands. Figured by R. Etheridge, jun. Same locality and Collection. (Page 110.)

Fig. 15.—*Pterinopecten cyclopterus*.—Phillips's type. Preserved in the Natural History Museum, South Kensington. (Page 64.)

Fig. 16.—*Pterinopecten cyclopterus*. A young example from Little Island, co. Cork. In the Collection of Mr. J. Wright. (Page 64.)

Figs. 17, 18.—*Pterinopecten cyclopterus*. The left and right valves of the same shell; the latter imperfect. Same locality and Collection. (Page 64.)

Fig. 19.—*Pterinopecten cyclopterus*. A left valve. Same locality and Collection. (Page 64.)

Fig. 20.—*Pterinopecten meleagrinoides*. A left valve. From Castleton. My Collection. (Page 62.)

Fig. 21.—*Pterinopecten meleagrinoides*. A left valve. Same locality and Collection. (Page 62.)

Fig. 22.—*Pterinopecten meleagrinoides*. A left valve. From Thorpe Cloud. My Collection. (Page 62.)

Fig. 23.—*Pterinopecten meleagrinoides*. A right valve. From Castleton. My Collection. (Page 62.)

Figs. 24, 25.—*Aviculopecten Carrolli*. Two left valves. From Little Island. In the Collection of Mr. J. Wright. (Page 97.)

Fig. 26.—*Aviculopecten Carrolli*. A left valve. From Castleton, Derbyshire. Showing broad, radiating colour-bands. My Collection. (Page 97.)

Fig. 27.—*Aviculopecten Carrolli*. A right valve; a cast. From Caherass, co. Limerick. In the Collection of the Geological Survey of Ireland. (Page 97.)

Fig. 28.—*Aviculopecten fallax*. The cast of a right valve. From Doohylebeg, co. Limerick. Same Collection. (Page 76.)

Fig. 29.—*Aviculopecten fallax*. A right valve. From Millicent, Kildare. In the Woodwardian Museum, Cambridge. (Page 76.)

Fig. 30.—*Aviculopecten fallax*. A left valve. From Gortnagrour, co. Limerick. In the Collection of the Geological Survey of Ireland. (Page 76.)

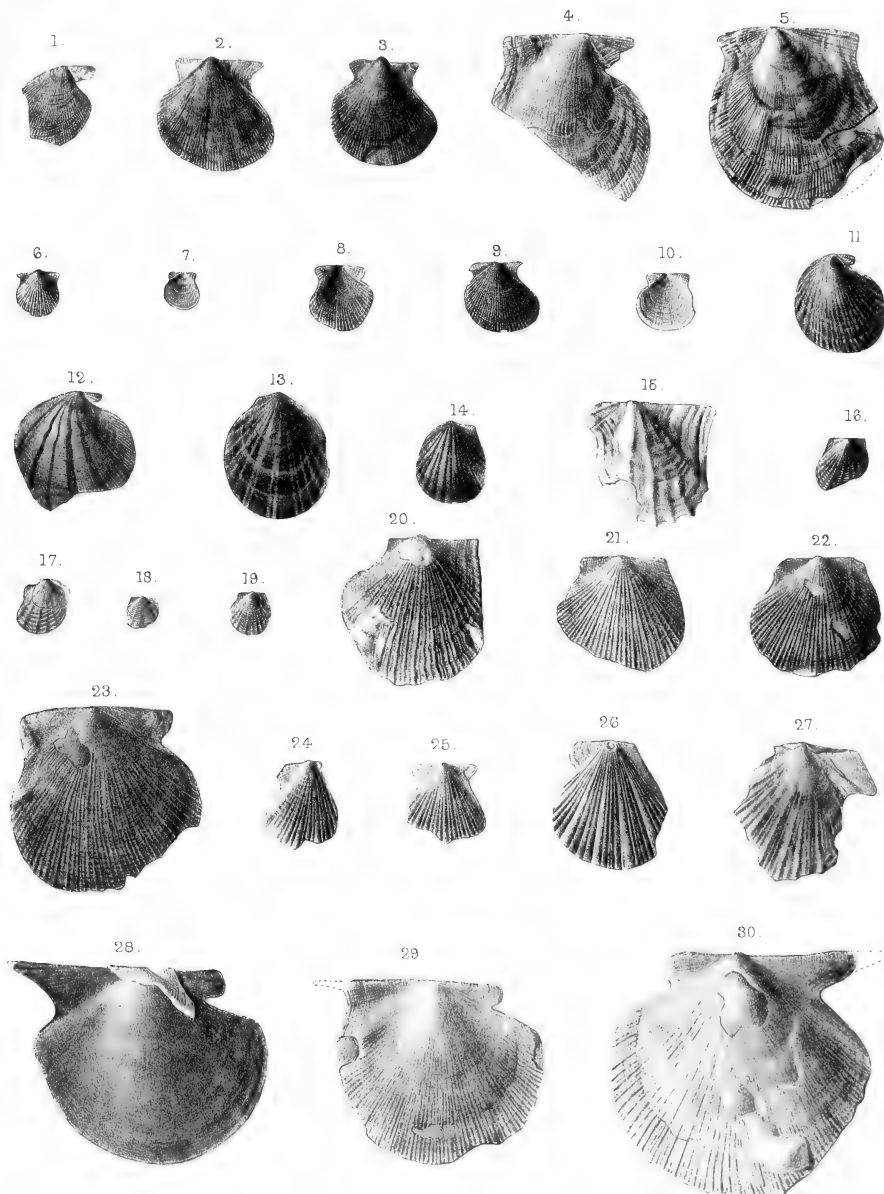


PLATE XVIII.

Fig. 1.—*Aviculopecten Losseni*. A left valve. From Angram Brook, Pendle Hill. My Collection. (Page 80.)

Fig. 2.—*Aviculopecten Losseni*. A left valve. Same horizon. My Collection. (Page 80.)

Fig. 3.—*Aviculopecten Forbesii*. A right valve, somewhat sheared. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 83.)

Figs. 4, 5.—*Aviculopecten Forbesii*. Same locality and Collection. (Page 83.)

Fig. 6.—*Aviculopecten Forbesii*. Two left valves. Same locality. York Museum. (Page 83.)

Fig. 7.—*Aviculopecten Forbesii*. M'Coy's type. From Millicent, Kildare. In the Griffith Collection, Science and Art Museum, Dublin. (Page 83.)

Figs. 8, 9.—*Eumicrotis ovalis*. The right and left valves, which have slipped past each other, of a specimen. From Settle. In the Woodwardian Museum, Cambridge. (Page 46.)

Fig. 10.—*Aviculopecten deornatus*. A right valve. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 100.)

Figs. 11, 12.—*Aviculopecten deornatus*. A left and a right valve. Same locality and Collection. (Page 100.)

Figs. 13, 14.—*Aviculopecten deornatus*. The left and right valves of a bivalved example. Same locality and Collection. (Page 100.)

Figs. 15—17.—*Aviculopecten macrotis*. Three left valves. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 84.)

Fig. 18.—*Aviculopecten macrotis*. A right valve, M'Coy's type. From Bruckless, co. Donegal. Griffith Collection, Museum of Science and Art, Dublin. (Page 84.)

Fig. 19.—*Aviculopecten decussatus*. A left valve, M'Coy's type. Preserved in the Museum of Science and Art, Dublin. (Page 79.)

Fig. 20.—*Aviculopecten decussatus*. A left valve, the type of *Pecten tripartitus*, M'Coy. Same Collection. (Page 79.)

Fig. 21.—*Syncyclonema Sowerbyi*. A left valve. No. 123 in the Woodwardian Museum, Cambridge. (Page 118.)

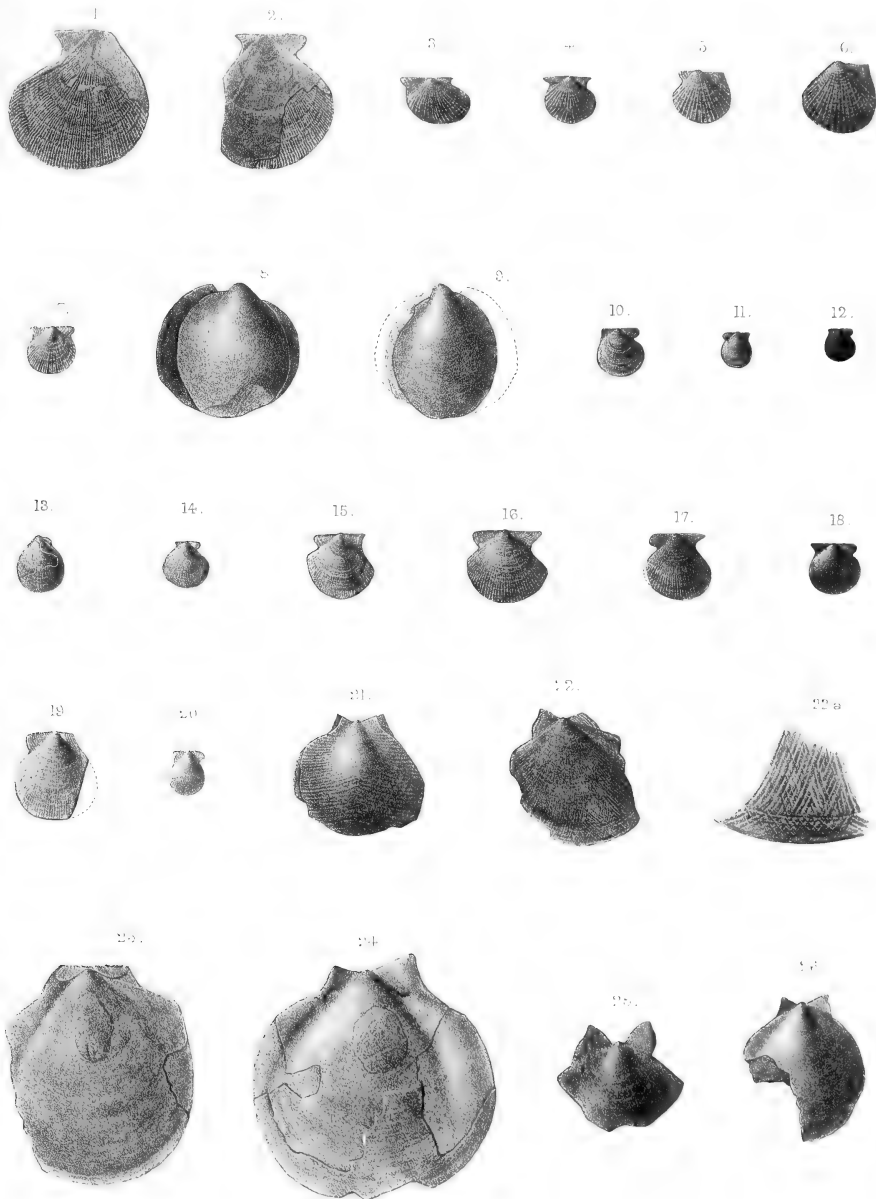
Fig. 22.—*Syncyclonema Sowerbyi*. A left valve. From the Yoredale Series of Swaledale. 22a. An enlarged area showing zigzag markings, due to removal of the outer layers of the shell. (Page 118.)

Fig. 23.—*Syncyclonema Sowerbyi*. A specimen with straight ears. From Poolvash, Isle of Man. (Page 118.)

Fig. 24.—*Syncyclonema Sowerbyi*. A full-grown shell, left valve. From Hill Bolton, Yorkshire. My Collection. (Page 118.)

Fig. 25.—*Syncyclonema Sowerbyi*. A fragment to show the great elevation of the ears. From Cork. In the Collection of Mr. J. Wright. (Page 118.)

Fig. 26.—*Syncyclonema Sowerbyi*. M'Coy's type. From Howth, co. Dublin. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 118.)



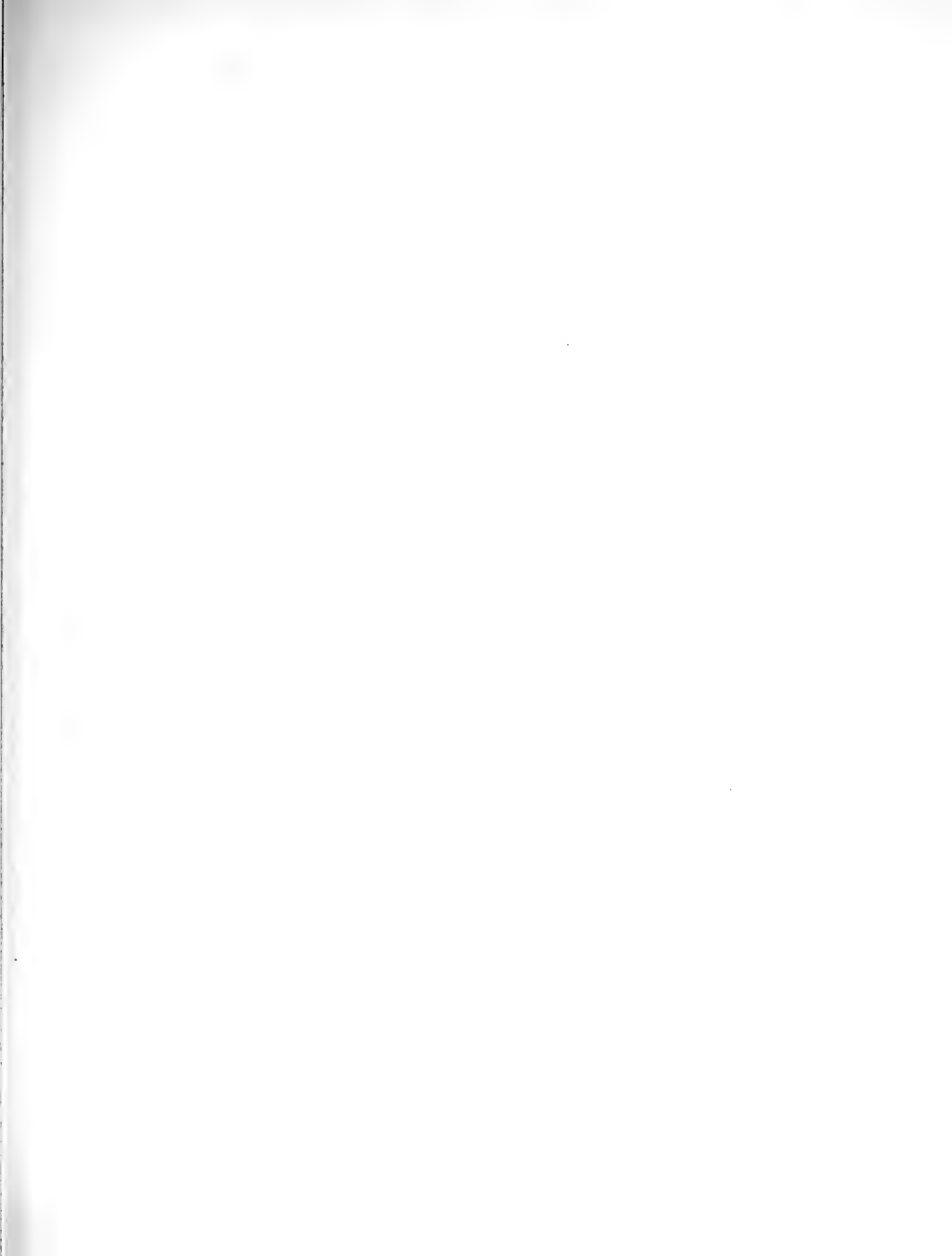


PLATE XIX.

Fig. 1.—*Obliquipecten levis*. The right valve. From the Carboniferous Limestone of Narrowdale. My Collection. (Page 115.)

Fig. 2.—*Obliquipecten levis*. The left valve. From the Carboniferous Limestone of Settle. Woodwardian Museum, Cambridge. (Page 115.)

Figs. 3—6.—*Syncyclonema carboniferum*. A series. From shales above the Gin Mine Coal, Nettlebank, Staffordshire. My Collection. (Page 120.)

Fig. 7.—*Limatulina alternata*. The type of M'Coy's *A. prisca*. Preserved in the Griffith Collection, Museum of Science and Art, Dublin. (Page 37.)

Fig. 8.—*Limatulina alternata*. A broader form. From Narrowdale, Staffordshire. My Collection. (Page 37.)

Fig. 9.—*Limatulina alternata*. A left valve. From Park Hill. My Collection. (Page 37.)

Fig. 10.—*Limatulina alternata*. A left valve. Same locality and Collection. (Page 37.)

Fig. 11.—*Limatulina desquamata*. A left valve. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 37.)

Fig. 12.—*Limatulina alternata*. A right valve. From Blackrock, co. Cork. In Mr. J. Wright's Collection. (Page 37.)

Fig. 13.—*Palaeolima levis*. A right valve. From Little Island, co. Cork. Same Collection. (Page 40.)

Figs. 14, 15.—*Palaeolima levis*. Two less oblique forms. Same locality and Collection. (Page 40.)

Fig. 16.—*Palaeolima levis*. A right valve. Same locality and Collection. (Page 40.)

Fig. 17.—*Palaeolima obliquiradiata*. A left valve. From Settle. In the Woodwardian Museum, Cambridge. (Page 40.)

Fig. 18.—*Palaeolima obliquiradiata*. The left valve of a bivalved example. Same locality and Collection. (Page 40.)

Fig. 19.—*Palaeolima obliquiradiata*. The right valve of the same shell. (Page 40.)

Fig. 20.—*Limatulina desquamata*. A left valve. From Settle. In the Woodwardian Museum, Cambridge. (Page 37.)

Fig. 21.—*Limatulina desquamata*. A left valve. Same locality and Collection. (Page 37.)

Fig. 22.—*Limatulina desquamata*. A left valve. From the Redesdale Ironstone. My Collection. (Page 37.)

Fig. 23.—*Limatulina desquamata*. A left valve. From the Redesdale Ironstone. My Collection. (Page 37.)

Fig. 24.—*Palaeolima simplex*. A right valve. From the Carboniferous Limestone of Poolvash, Isle of Man. My Collection. (Page 39.)

Fig. 25.—*Palaeolima simplex*. A left valve. Same locality and Collection. (Page 39.)

Fig. 26.—*Palaeolima simplex*. A right valve. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 39.)

Fig. 27.—*Palaeolima simplex*. A left valve. Same locality and Collection. (Page 39.)

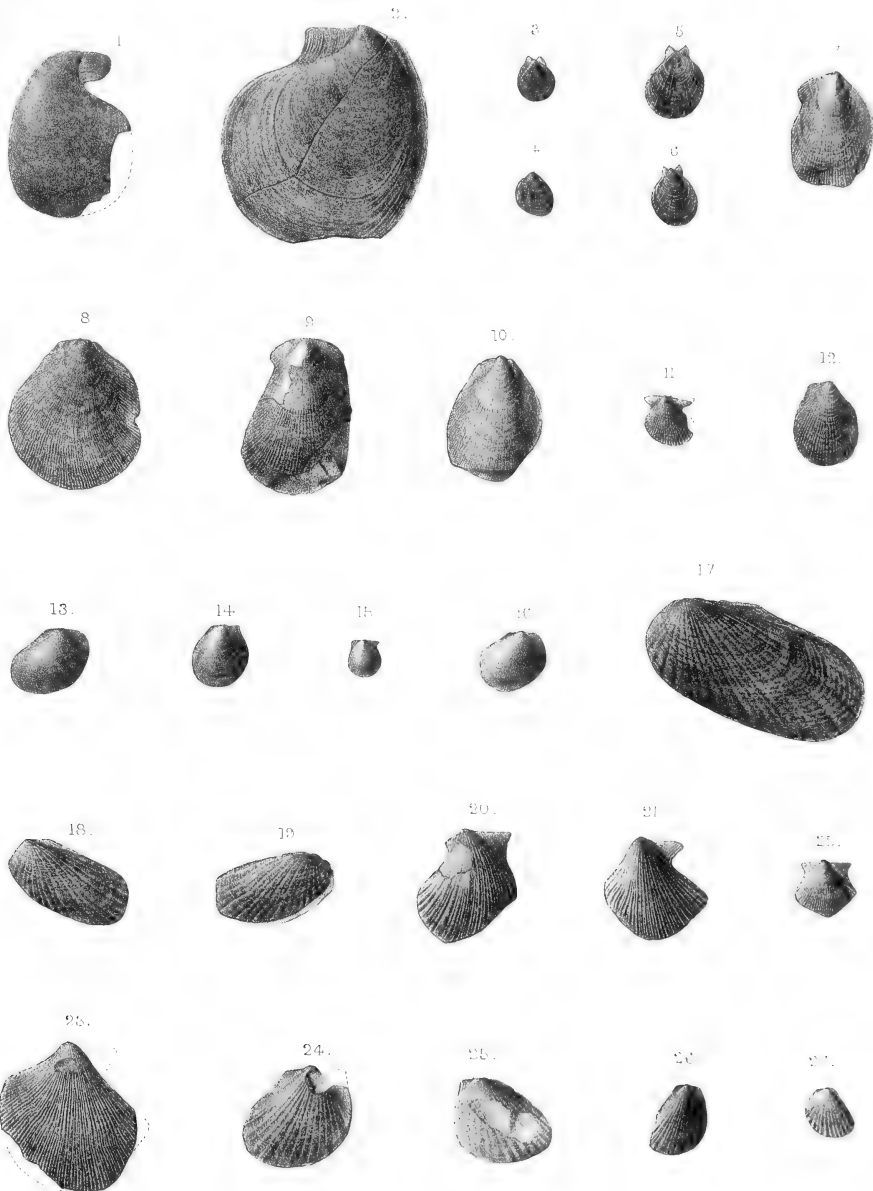


PLATE XX.

Fig. 1.—*Pseudamysium Redesdalense*. A left valve with the shell preserved, showing radiating colour bands. Redesdale Ironstone. My Collection. (Page 109.)

Fig. 2.—*Pseudamysium Redesdalense*. A left valve, incomplete at the posterior margin. Same locality and Collection. (Page 109.)

Figs. 3, 4.—*Pseudamysium Redesdalense*. The left and right valves of the same shell, showing the difference between the two. Same locality and Collection. (Page 109.)

Fig. 5.—*Pseudamysium Redesdalense*.—A right valve. Same locality and Collection. (Page 109.)

Fig. 6.—*Pseudamysium Redesdalense*. A cast of the interior, showing the adductor scar of the right valve. Same locality and Collection. (Page 109.)

Fig. 7.—*Pseudamysium concentrico-lineatum*. The left valve. From Castleton. In the Manchester Museum, Owens College. (Page 111.)

Fig. 8.—*Pseudamysium concentrico-lineatum*. A left valve. From Castleton. My Collection. (Page 111.)

Fig. 9.—*Pseudamysium concentrico-lineatum*. A left valve. From the Carboniferous Limestone of Wetton, N. Staffordshire. My Collection. (Page 111.)

Fig. 10.—*Pseudamysium concentrico-lineatum*. A cast of the left valve. From Askeaton, co. Limerick. In the Collection of the Geological Survey of Ireland. (Page 111.)

Figs. 11, 12.—*Pseudamysium ellipticum*. The left and right valves of the same shell, showing the obscure radiating lines on the left and the smooth right valve. From Castleton. My Collection. (Page 103.)

Fig. 13.—*Pseudamysium ellipticum*. The left valve. Used and figured as the type by Phillips. In the Gilbertson Collection, Natural History Museum, South Kensington. A little incomplete in front. (Page 103.)

Fig. 14.—*Pseudamysium ellipticum*. Not the type of *Pecten elongatus*, McCoy. A left valve. From Millicent, co. Kildare. In the Griffith Collection, Museum of Science and Art, Dublin. A compressed and flattened form. (Page 103.)

Fig. 15.—*Pseudamysium ellipticum*. A left valve. From Castleton. My Collection. (Page 103.)

Fig. 16.—*Pseudamysium ellipticum*. A left valve. From Craigenglen. In the Collection of the Geological Survey of Scotland. (Page 103.)

Fig. 17.—*Pseudamysium ellipticum*. A left valve. Same locality and Collection. (Page 103.)

Fig. 18.—*Pseudamysium ellipticum*. A right valve, more gibbose than usual. From Thorpe Cloud. My Collection. (Page 103.)

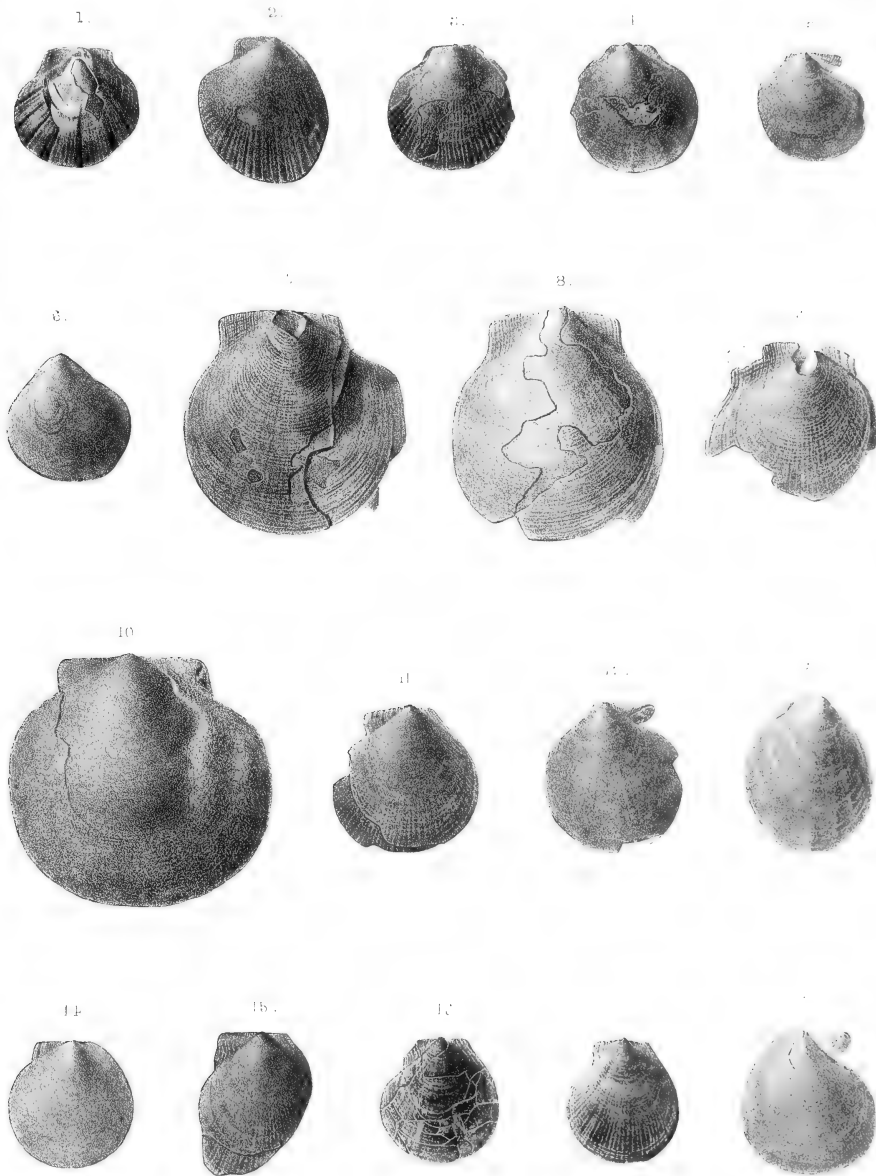


PLATE XXI.

Fig. 1.—*Amusium planicostatum*. A right valve. From Little Island, co. Cork. In the Collection of Mr. J. Wright. (Page 124.)

Fig. 2.—*Amusium planicostatum*. A left valve, the type of M'Coy's *Pecten planicostatus*. Same locality. In the Griffith Collection, Museum of Science and Art, Dublin. (Page 124.)

Fig. 3.—*Amusium planicostatum*. A left valve. Same locality. Mr. J. Wright's Collection. (Page 124.)

Fig. 4.—*Amusium tenue*. The right valve. From East Kilbride. In the Collection of Mr. J. Neilson. (Page 123.)

Fig. 5.—*Amusium tenue*. A right valve, showing radiating ridges through the shell. Same locality and Collection. (Page 123.)

Fig. 6.—*Amusium tenue*. A left valve. From Northumberland. In the York Museum. (Page 123.)

Fig. 7.—*Amusium concentricum*. A right valve. From Croag, co. Limerick. In the Collection of the Geological Survey of Ireland. (Page 122.)

Fig. 8.—*Amusium concentricum*. A right valve. From Thorpe Cloud. My Collection. (Page 122.)

Fig. 9.—*Amusium concentricum*. A right valve. From St. Doulaghs, co. Dublin. My Collection. (Page 122.)

Fig. 10.—*Amusium concentricum*. A right valve. From Thorpe Cloud. My Collection. (Page 122.)

Fig. 11.—*Amusium concentricum*. A specimen showing very distinct and regular concentric lines. From Little Island, co. Cork. Mr. J. Wright's Collection. (Page 122.)

Fig. 12.—*Pseudamusium gibbosum*. A left valve. From Castleton. My Collection. (Page 106.)

Fig. 13.—*Pseudamusium anisotum*. Phillips's type specimen. No locality given. In the Gilbertson Collection, Natural History Museum, South Kensington. (Page 104.)

Fig. 14.—*Pseudamusium anisotum*. The left valve of a medium-sized shell. From Park Hill. My Collection. (Page 104.)

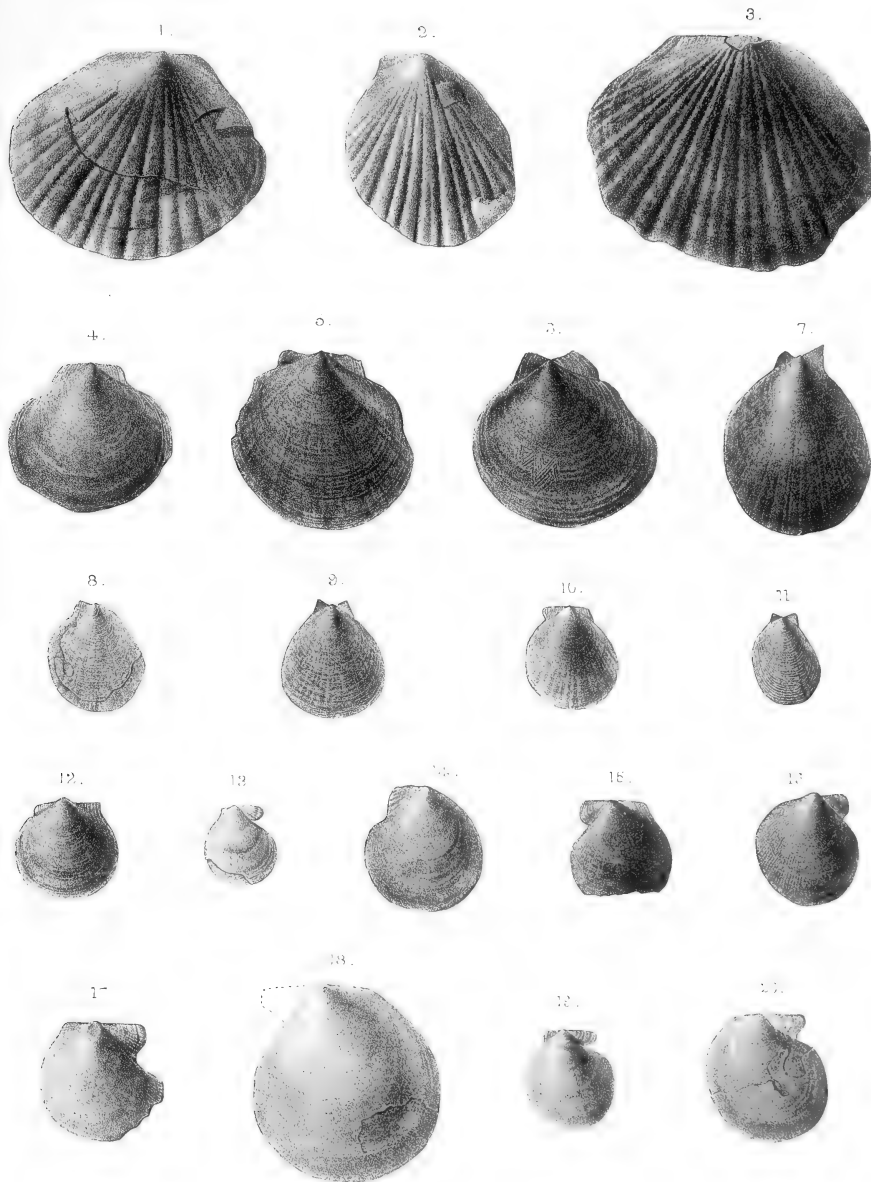
Figs. 15, 16.—*Pseudamusium anisotum*. The left and right valves of a bivalve example. From Hill Bolton, Yorkshire. My Collection. (Page 104.)

Fig. 17.—*Pseudamusium anisotum*. The right valve. From Thorpe Cloud. My Collection. (Page 104.)

Fig. 18.—*Pseudamusium anisotum*. A large example of the left valve; the anterior ear has been broken off. Same locality and Collection. (Page 104.)

Fig. 19.—*Pseudamusium anisotum*. A right valve. Same locality and Collection. (Page 104.)

Fig. 20.—*Pseudamusium anisotum*. A right valve, with remains of concentric colour-bands. Same locality and Collection. (Page 104.)



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MONOGRAPH

OF THE

CARBONIFEROUS CEPHALOPODA

OF

IRELAND.

BY

ARTHUR H. FOORD, PH.D. (MÜNCH.), F.G.S.

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PART V.
CONTAINING THE FAMILIES
GLYPHIOCERATIDÆ (CONCLUDED) AND PROLECANITIDÆ,
WITH TITLE-PAGE AND INDEX,

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PERICYCLUS BAILYI, *G. C. Crick*. Plate XL, figs. 1—3.

1899. PERICYCLUS BAILYI, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 438, fig. 6.

Description.—Shell discoidal, somewhat compressed, and rather widely umbilicated; greatest thickness close to the umbilical margin, about four-ninths of the diameter of the shell, height of outer whorl about three-sevenths of that diameter. Whorls possibly six or seven, but in default of perfect adult specimens the number must for the present remain doubtful. Inclusion fully three-fourths. Umbilicus about four-elevenths of the diameter of the shell in width, very deep, exposing all the inner whorls, the margin subangular, sloping inwards, steep. Whorl semi-elliptical in cross-section, slightly wider than high, indented to about three-eighths of its height by the preceding whorl; sides very slightly convex, merging in the rounded periphery.

Body-chamber occupying the whole of the last whorl.

Suture-line as in Pl. XL, fig. 3.

Test ornamented with fairly regular, not very prominent ribs, which are stronger in the young shell than in the adult, in which they become almost obsolete; they form a gentle, backwardly directed curve on the sides of the shell, and are sharply bent backwards upon the periphery. Constrictions appear at intervals, about six being counted in a whorl; their direction corresponds exactly with that of the ribs.

Dimensions.

	Type specimen in the British Museum (No. C. 298).		Specimen from St. Don- lugh's, in the Wood- wardian Museum, Cam- bridge (No. 439).
Diameter of shell (body-chamber, incom- plete in Cambridge specimen)	97 mm.	.	55 mm.
„ umbilicus (edge to edge)	35 „	.	20 „
„ „ (suture to suture)	30 „	.	17 „
Height of outer whorl	41 „	.	24 „
„ above preceding whorl (about)	26 „	.	— „
Thickness at umbilical margin (about)	44 „	.	26 „

Affinities.—The relations of this species to *Pericyclus Foordi* and to *P. rotuliformis* are referred to under the descriptions of these species.¹ The great depth of the umbilicus and the comparative feebleness of the ribbing, together with the rounded form of the periphery, are its distinguishing features.

Remarks.—As regards the form of the shell and the character of the ornaments,

¹ *P. Foordi*, p. 141; *P. rotuliformis*, p. 148.

the following species, it will be observed, group themselves very naturally together, viz. *Pericyclus Floordi*, *P. subplicatilis*, *P. rotuliformis*, and *P. Bailyi*. As might be anticipated, the young or smaller shells in this group are difficult to discriminate, and, unfortunately, a large gradational series of individuals, so much to be desired among fossils, both on taxonomic and biological grounds, is here wanting. So far, however, as the material indicates, the two forms figured on Pl. XL seem to be quite distinct, the main feature (one which does not appear so striking in the figures as in reality) consisting in the more compressed shape of *P. rotuliformis*, as compared with that of *P. Bailyi*. The ribbing also is seen to be more scanty in the former than it is in the latter.

Locality.—St. Doulagh's, county of Dublin.

PERICYCLUS ROTULIFORMIS, *G. C. Crick*. Plate XL, figs. 4—7.

1899. PERICYCLUS ROTULIFORMIS, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 434, fig. 3.

Description.—Shell discoidal, rather compressed, somewhat widely umbilicated; greatest thickness at the umbilical margin, about three-eighths of the diameter of the shell; height of outer whorl in about the same ratio to that diameter. Whorls not less than four and a half, but possibly exceeding that number, the absence of the body-chamber in all the specimens that have come under my notice making an exact computation unattainable. Inclusion two-thirds. Umbilicus of moderate depth, about three-tenths of the diameter of the shell in width, exposing the inner whorls; the sides slightly sloping, not very deep, with subangular margins. Whorls subcordate in cross-section, very slightly higher than wide, the difference between the two dimensions being scarcely appreciable, as will be seen in the table given farther on. The indentation of the preceding whorl amounts to about one-third of the height of the last one. Sides very slightly convex, merging in the narrowly rounded periphery. Umbilical zone (judging from natural casts only) fairly well defined, sloping towards the centre of the umbilicus, thus making an obtuse angle with the sides. Body-chamber occupying rather more than an entire whorl. The suture-line of this species (Pl. XL, fig. 7) is here figured for the first time.

Test (judging by the fragments of it preserved) ornamented with feeble ribbing, which appears to be rather more conspicuous upon the cast. The ribs bend rather abruptly backwards upon the sides of the shell, and make a rather narrow and linguiform hyponomic sinus upon the periphery. Periodic constrictions occur at irregular intervals and form very deep grooves upon the cast, but are shallower where the test is present; there are generally about seven of them in the circuit of a whorl, and they form a very conspicuous feature in this species. Their direc-

tion exactly corresponds with that of the ribs. Very fine transverse lines cover the whole of the test, but they are too delicate to leave any impression upon the cast. Beginning with the first whorl and extending to the penultimate one are a series of small but conspicuous nodes or tubercles situated at the edge of the umbilicus; these apparently become obsolete on the last whorl. I have observed them only upon a specimen from which the rock has been entirely removed from the umbilical cavity (Pl. XL, fig. 5).

Dimensions.

	Type specimen in Museum of Science and Art, Dublin.		Another specimen in Museum of Science and Art, Dublin.
Diameter of shell . . .	81	mm.	73 mm.
„ umbilicus (edge to edge) .	29	„	30 „
„ „ (suture to suture) .	23	„	about 25 „
Height of outer whorl . .	32.5	„	28 „
„ above preceding whorl .	22	„	about 22 „
Thickness at umbilical margin .	32	„	33 „

Affinities.—Its narrowly rounded periphery, shallower umbilicus, and strong constrictions distinguish this species from *Pericyclus Baillyi*, Crick (p. 147), which it superficially resembles. A rather coarsely ribbed, thick form, which may be the young of *P. Foordi*, Crick,¹ is by these characters equally excluded from the present species.² The deep constrictions in the latter cause it to be easily recognised in all stages of growth; these constrictions are somewhat deeper upon the cast, but among numerous specimens collected only fragments of the test have been preserved, so that this has not in any case presented a difficulty.

Remarks.—Among the specimens of *P. rotuliformis* submitted by the writer to Mr. Crick,³ he describes one which is somewhat more inflated than the type specimen from which his description was chiefly drawn up. In all other respects it agrees with the latter. The dimensions of both are given above.

The smaller of the specimens figured (Pl. XL, fig. 5) belongs to the Woodwardian Museum, Cambridge, and was kindly lent to me by the museum authorities, along with other specimens.

Localities.—St. Doulagh's, county of Dublin; Glenbane, county of Limerick.

¹ This monograph ('Mem. Palaeont. Soc.,' vol. for 1901), p. 141.

² This monograph, p. 142.

³ 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 436.

PERICYCLUS Plicatilis, *L. G. de Koninck*, sp. Plate XLI, figs. 2 *a—d*.

1881. GONIATITES Plicatilis, *L. G. de Koninck*. Sur quelques céphalopodes nouveaux du calcaire carbonifère de l'Irlande. *Ann. Soc. géol. de Belgique*, tom. ix, 1881-82 (Mémoires), pp. 50-60, pl. v, figs. 3, 4 (not pl. vi, as erroneously referred to).

1899. PERICYCLUS Plicatilis, *G. C. Crick*. *Ann. Mag. Nat. Hist.*, ser. 7, vol. iii, p. 441.

Description.—Shell subglobose, rather widely umbilicated; greatest thickness at the umbilical margin, about two-thirds of the diameter of the shell; height of outer whorl about two-fifths of the diameter of the shell. Number of whorls not ascertainable; inclusion almost complete; umbilicus deep, about one-third of the diameter of the shell in width, exposing the angular edges of the inner whorls. Whorl very distinctly semilunate in cross-section, much wider than high; indented to about two-thirds of its height by the preceding whorl. Periphery broadly arched, imperfectly defined, merging into the slightly convex sides. Umbilical zone well defined, rather wide, nearly perpendicular to the plane of symmetry of the shell with a little inclination towards the centre of the umbilicus.

Body-chamber occupying at least the whole of the last whorl. Aperture not preserved, but from the direction of the ribbing it would appear to have had a broad and moderately deep hyponomic sinus.

Suture-line as in Pl. XLI, fig. 2 *d*.

Test ornamented with slender but prominent ribs, which, arching forwards upon the sides of the shell, bend somewhat abruptly backwards and form upon the periphery a broad and moderately deep hyponomic sinus; the interspaces are somewhat wider than the ribs; the whole surface of the test is covered with fine lines of growth.

Dimensions.

			Type specimen in Museum of Science and Art, Dublin (Geological Survey Collection).
Diameter of shell (about)	.	.	85 mm.
„ umbilicus (edge to edge)	.	.	38 „
„ „ (suture to suture)	.	.	30 „
Height of outer whorl (about)	.	.	34 „
„ above preceding whorl	.	.	21 „
Thickness at umbilical margin (about)	.	.	60 „

Remarks.—De Koninck's measurements of this species are:—Longitudinal

diameter, 85 mm.; transverse diameter, 58 mm.; diameter of umbilicus, 30 mm.; median height of the aperture, 21 mm. These agree very closely with the measurements given above, though the specimen appears to have been fractured a little after it had left de Koninck's hands. His drawing represents it as undistorted, this circumstance probably causing its identity to be afterwards overlooked, for it has been labelled "*Goniatites Wrightii*," as if it were an undescribed species; this name exists only on the tablet.

Affinities.—This species has been mistaken for *Pericyclus fasciculatus* (= *P. furcatus*), McCoy, from which it is easily distinguished by the larger number and less prominent character of its ribs, and the absence of bifurcation in them. It is also a much more inflated shell; this character, together with its deep umbilicus, distinguishes it also from *P. subplicatilis*, Crick. *P. finatus*, J. Sowerby, may be an allied form, but it has more numerous whorls and is a more compressed shell than *P. plicatilis*; the plications also are much coarser in the former species. *Pericyclus plicatilis* differs, according to Mr. Crick, from *P. Hauehecornei*, Holzapfel,¹ in its coarser ornaments and much more inflated whorls.

Locality.—Kilmacat, county of Limerick (erroneously written "Kilmacan" by de Koninck).

PERICYCLUS? CLANENSIS, *G. C. Crick*. Plate XLI, figs. 1 a—c.

1888. PERICYCLUS CLANENSIS, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 437, fig. 4.

Description.—Shell discoid, rather compressed, especially laterally, somewhat narrowly umbilicated; greatest thickness near the edge of the umbilical margin, rather more than four-elevenths of the diameter of the shell. Whorls few; their number not ascertainable in the only specimen at present known; inclusion nearly two-thirds; umbilicus shallow, rather more than one-fourth of the diameter of the shell in width, with narrowly rounded margin. Whorl semi-elliptical in cross-section, somewhat higher than wide; indented to rather more than one-third of its height by the preceding whorl. Periphery convex, imperfectly defined; sides slightly convex, somewhat flattened near the umbilicus; umbilical zone extremely narrow, sloping a little towards the umbilicus. Body-chamber slightly exceeding the last whorl in length; aperture not present, but, judging by the lines of growth, there was probably a moderately prominent lateral crest and a broad and rather deep hyponomic sinus. Chambers (near the base of the body-chamber where alone they

¹ "Die Cephalopoden-führenden Kalke des unteren Carbon von Erdbach-Breitscheid bei Herborn." ('Pal. Abhandl. Dames und Kayser'), Bd. v, Heft 1, 1889, p. 36, pl. ii, figs. 8—11 (especially figs. 11, 11 a).

are seen) shallow; suture-line as in Pl. XLI, fig. 1c, but the apex of the lateral lobe is not represented sufficiently acute. Test ornamented with coarse and rather irregular ribbing or lines of growth, which, on leaving the umbilical margin, bend backwards across the sides of the shell, and in passing over the periphery constitute the broad and rather deep sinus already referred to. The lines or ribs here described (they are somewhat obscure) are seen more distinctly upon the cast than upon the test, only fragments of which are preserved. Some faint constrictions are seen upon the cast of the body-chamber conforming in their direction to the lines of growth.

Dimensions.

		Type specimen in Museum of Science and Art, Dublin.
Diameter of shell	.	120 mm.
„ umbilicus on the cast (edge to edge)	.	33.5 „
„ „ „ (suture to suture)	.	31 „
Height of outer whorl	.	52 „
„ above preceding whorl	.	33.5 „
Thickness at umbilical margin (about)	.	44 „

Affinities.—The comparative width of the shallow umbilicus and the compressed form of the shell are features which bring this species into relationship with *Pericyclus Leesonii* (p. 153), but the latter has a much narrower periphery, and is on the whole a flatter and more slender shell than *P. Clanensis*.

Remarks.—The present species is founded upon a single specimen contained in the Museum of Science and Art, Dublin, and was originally labelled "*Goniatites Brownii*," McCoy,¹ but it bears very little resemblance to that species.

Mr. Crick² referred the present species to *Pericyclus*, but its claim to belong to that genus must be held to be somewhat doubtful, as the surface of the test is badly preserved, and only fragments of it remain. The chief diagnostic character of *Pericyclus*³ is the presence of "strong, direct, transverse ribs."

The late Professor Hyatt distinguished *Pericyclus* chiefly by its suture-line, in which he recognised a spatulate external saddle, and an additional broad, angular, lateral lobe, making two lateral lobes instead of one. This peculiarity is, I believe, met with only in *P. virgatus*, de Kon.; it is figured by Holzapfel.⁴ The latter species, along with *P. princeps*, de Kon., formed Mojsisovics' genus *Pericyclus*. Great variability is observable on comparing together the suture-line in different species of *Pericyclus*, and it was upon this ground that Holzapfel urged that the

¹ 'Synops. Carb. Foss. Ireland,' 1844, p. 12, pl. iv, fig. 17.

² 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 436.

³ 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1897, pp. 143, 144, figs. 68, 69 (respectively *P. princeps* and *P. virgatus*—suture-line).

⁴ 'Palaeont. Abhandl.,' Dames und Kayser, vol. v, I, p. 34, pl. iii.

suture-line must not be relied upon too much for diagnostic purposes, but rather the ornamentation of the shell, and also the absence of a sinus, lateral or peripheral, in the border of the aperture. If Holzapfel be correct this latter feature casts a further doubt upon the generic position assigned to this species, which clearly has a peripheral sinus.

Locality.—County of Kildare (exact locality unrecorded).

PERICYCLUS? LEESONI, *G. C. Crick*, sp. Plate XLVI, figs. 6 *a—c*.

1899. PROLECANITES LEESONI, *G. C. Crick*. *Ann. Mag. Nat. Hist.*, ser. 7, vol. iii, p. 451, figs. 15 *a, b*.

Description.—Shell discoid, compressed, umbilicated; the greatest thickness at the umbilical margin, about one-third of the diameter of the shell; height of the outer whorl about four-ninths of the same. Number of whorls not ascertainable; inclusion nearly three-fourths; umbilicus rather shallow, with steeply sloping sides and subangular margin (on the east), its width about two-sevenths of the diameter of the shell. Whorl subsagittate in section, the width nearly three-fourths of the height, indented to about two-sevenths of its height by the preceding whorl; periphery narrow, somewhat flattened, especially towards the aperture, obscurely defined; sides very slightly convex; umbilical zone narrow, well defined, sloping towards the centre of the umbilicus. Body-chamber probably occupying at least a complete whorl; aperture not seen. Test so much eroded as to leave on the sides only obscure traces of ornamentation, but the indications are strongly in favour of the shell having been transversely costated; remains of ribbing are obscurely visible on the sides and more plainly upon the periphery where the test is preserved in places, their direction here indicating a rather deep and narrow hyponomic sinus. As far as can be judged the ribbing seems to have been only slightly curved upon the sides. Two shallow constrictions are present upon the east, one near the commencement of the body-chamber, the other more posteriorly situated; their direction conforms to that of the ribbing.

Dimensions.

Type specimen in the Museum
of Science and Art, Dublin
(Geological Survey Collec-
tion, No. C. 748).

Diameter of shell	90	mm.
„ umbilicus (edge to edge)	27	„
„ „ (suture to suture)	24	„
Height of outer whorl	40·5	„
„ above preceding whorl	28	„
Thickness at umbilical margin	29·5	„

Remarks.—Since Mr. Crick described this fossil I have been enabled to expose a portion of the suture-line (Pl. XLVI, fig. 6 c). This shows that the species has no relationship with *Prolecanites*, as assumed by its author, who had of course not seen the suture-line when he wrote his description. The presence of ribbing (which may with strong probability be admitted) and the general character of the suture-line leaves little doubt that this species belongs to *Pericyclus*; its relationship to *P. Clanensis*, G. C. Crick, is pointed out under the description of that species.

Locality.—Glenbane East, county of Limerick.

Genus GLYPHIOCERAS, *Hyatt*, 1883 (emend. *Holzappel*, 1889).

Sub-genus SPHENOCERAS,¹ sub-gen. nov.

GLYPHIOCERAS (SPHENOCERAS) SPHERICUM, *W. Martin*, sp. Plate XLII, figs. 1 a, b, 2.

1809. CONCHYLIOLITHUS NAUTILITES SPHERICUS, *W. Martin*. Petrificata Derbiensia, p. 15, pl. vii, figs. 3—5.
1814. AMMONITES SPHERICUS, *J. Sowerby*. Min. Conch., vol. i, p. 116, pl. liii, fig. 2.
1825. GONIATITES SPHERICUS, *G. de Haan*. Monogr. Ammon. et Goni., p. 159.
1828. ORBULITA SPHERICA, *J. Fleming*. History of British Animals, p. 248.
1829. GLOBITES SPHERICUS, *F. Holl*. Handb. d. Petrefakt., p. 227.
1832. AMMONITES CARBONARIUS (pars), *L. von Buch*. Phys. Abhandl. d. k. Akad. d. Wissensch. Berlin for 1830, p. 176, pl. ii, figs. 9, 9^I—9^{III} (not 9^{IV}).
1836. GONIATITES SPHERICUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 4—6.
- AMMONITES SPHERICUS, *W. Buckland*. Geol. and Mineral., vol. ii, p. 61, pl. xl, fig. 3.
1837. — — *H. E. Beyrich*. De Goniatitibus in montibus rhenanis occurrentibus, p. 13.
- — — — — Beitr. z. Kenntn. d. Verstein. d. rhein. Uebergangsgeb., p. 38.
- 1842-44. — — *L. G. de Koninck*. Descrip. Anim. Foss. Terr. Carb. Belgique, p. 570, pl. xlix, fig. 6; pl. i, figs. 9, 10.
1843. GONIATITES SPHERICUS, *J. Morris*. Cat. Brit. Foss., p. 180.
1844. — — *F. M'Coy*. Synops. Carb. Foss. Ireland, p. 15.
1846. — — (pars), *F. A. Quenstedt*. Petrefact. Deutschl., Bd. i (Cephalopoden), p. 66, pl. iii, fig. 11 (excl. figs. 10 a—d).
1848. — — *J. H. Cumming*. Isle of Man, p. 357.

¹ Referring to the wedge-shaped outline of the lobes and saddles. For definition of this sub-genus see Appendix, p. 218.

1848. GONIATITES SPHÆRICUS, *H. G. Bronn*. Gesch. d. Natur, Bd. iii, p. 544.
1850. AGANIDES SPHÆRICUS (pars), *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 15.
1852. AMMONITES SPHÆRICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 471.
GONIATITES SPHÆRICUS, *F. A. Quenstedt*. Handb. d. Petrefact., p. 351, pl. xxvi, fig. 25.
1854. — — — *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
1855. AGANIDES SPHÆRICUS, *F. McCoy*. Brit. Pal. Foss., p. 566.
- 1855-57. GONIATITES SPHÆRICUS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1860. — — — *E. d'Eichwald*. Lethæa Rossica, vol. i, p. 1322.
1862. — — — *T. Wardle*. In *J. Sleight's History of Ancient Leek*, p. 281, pl. i, fig. 3.
1867. — — — *H. Trautschold*. Bull. Soc. Imp. Nat. Moscou, vol. xl, No. 3, p. 44, pl. v, fig. 10.
1875. — — — *W. H. Baily*. Fig. Charact. Brit. Foss., p. 117, pl. xl, figs. 9 a, b.
1876. — — — *J. Armstrong, J. Young, and D. Robertson*. Cat. Western Scottish Foss., p. 58.
1878. — — — *G. A. Lebour*. Geology of Northumberland, p. 68.
1880. — — — (pars), *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v.), pt. 2, p. 97, pl. xlvii, figs. 3-5.
1883. — — — *L. G. de Koninck*. Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.
- GLYPHIOCERAS SPHÆRICUM, *A. Hyatt*. Genera of Fossil Cephalopods; Proceed. Boston Soc. Nat. Hist., vol. xxii, p. 329.
- — — CARBONARIUM (pars), *A. Hyatt*. Ibid., vol. xxii, p. 329.
1885. GONIATITES SPHÆRICUS, *F. A. Quenstedt*. Handb. d. Petrefact., 3rd ed., p. 538, pl. xlii, fig. 3.
- — — *G. H. Morton*. Proceed. Liverpool Geol. Soc., vol. iv, p. 316: "Carboniferous Limestone and Cefn-y-fedw Sandstone of Flintshire."
1887. — — — *D. L. Mallada*. Mem. Com. del Mapa Geológico de España, vol. i, pt. 2, p. 664, pl. iii, figs. 1, 2.
1888. — — — *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 312.
1889. GLYPHIOCERAS SPHÆRICUM, *E. Holzapfel*. Palæont. Abhandl., Dames und Kayser, Bd. v, 1, p. 26.
1890. — — — *G. Steinmann und L. Döderlein*. Elemente der Palæontologie, pt. 2, p. 393.
1891. GONIATITES (GLYPHIOCERAS) SPHÆRICUS, *H. Credner*. Elemente der Geologie, p. 459, fig. 277.
1893. GLYPHIOCERAS SPHÆRICUM, *A. Hyatt*. Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, pp. 471, 472.

1895. GONIATITES SPHÆRICUS, *G. H. Morton*. Proc. Liverpool Nat. Field Club for 1894, p. 23.
- GLYPHIOCERAS SPHÆRICUM, *F. Bernard*. Éléments de Paléontologie, p. 649, fig. 345 a.
- GONIATITES (GLYPHIOCERAS) SPHÆRICUS, *K. A. v. Zittel*. Grundzüge der Paläontologie, p. 399, fig. 1082.
1897. GLYPHIOCERAS SPHÆRICUM, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 157, figs. 73 a—c.
- — — *James Perrin Smith*. "Development of Glyphioceras and the Phylogeny of the Glyphioceratidæ;" Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 113, 115.
1900. — — — *A. Hyatt*. In translation of Karl A. von Zittel's Elements [Grundzüge] of Palæontology, edited by Charles R. Eastman, p. 552, fig. 1133.
- 1900–1901. GONIATITES SPHÆRICUS, *G. H. Morton*. "The Carboniferous Limestone of Anglesey," Proc. Liverpool Geol. Soc., p. 52.

Description.—"Shell globular, greatest thickness almost close to the edge of the umbilicus, about three-fourths of the diameter of the shell in the adult, proportionately greater in the young; height of outer whorl about four-ninths of the diameter of the shell. Whorls eight to ten; inclusion almost complete; umbilicus rather small, acute-edged, a little more than one-sixth of the diameter of the shell in width, with steep sides. Whorl semilunate in section, its height about three-fifths of its width; indented to rather more than one-half of its height by the preceding whorl; periphery broadly convex; sides convex, very slightly depressed around the umbilicus in the adult; inner area nearly perpendicular to the plane of symmetry. Body-chamber occupying the whole of the last whorl; aperture not seen. Chambers not very deep, about eighteen in a whorl. [Suture-line as in Pl. XLII, figs. 1 a, b, 2.] Test with fine spiral striæ, rarely preserved; internal casts with obscure transverse striæ, and at intervals with very shallow constrictions." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Dimensions.

	Young specimen (cast) from Bantry, in Mr. Joseph Wright's Collection.			
Diameter of shell	28 mm.
„ umbilicus	7 „
Height of outer whorl (about)	12 „
Thickness at umbilical margin (about)	22 „

The shell attains a diameter of 60 mm. with a thickness of 46 mm.

Affinities.—This species is distinguished from *Glyphioceras striatum*, J. Sow., by its more globose form, and by its suture-line.

Remarks.—This is a common and widely distributed species, as the long list of references to it at the head of the description testifies. It has been found in the British Isles, Belgium, and the Hartz. It is easily recognised by its globular shape, and the suture-line is also characteristic. Casts of it are more frequently met with than specimens having the shell preserved (probably owing to the tenuity of the test); hence the suture-line is generally exposed.

This species, like *G. striatum* (p. 160), appears to be rare in Ireland, and I can only record two localities for it. The specimen from which McCoy drew up the description in his 'Synopsis' (loc. cit.) belonged apparently to a private collection, as it is contained in a list of species to which the following heading is appended:—"The following fossils are described in my Synopsis, though not contained in the cabinets" [*i. e.* those belonging to Sir R. Griffith's Collection]. The Goniatites enumerated in this list are *G. Browni*, *G. crenistria*, *G. sphaericus*, *G. spiralis*, and *G. vittiger*. No localities are attached to them.

The largest individuals belonging to the present species have been found in Belgium; de Koninck records one having a diameter of 70 mm. and a thickness of 55 mm. as the largest he had met with. McCoy's specimen ('Synopsis,' loc. cit.) measured 46.5 mm. in diameter and 38 mm. in thickness.

Localities.—Loughshinny, county of Dublin; near Bantry, county of Cork. (The specimen from the former locality is contained in the Dublin Museum of Science and Art—Geological Survey Collection; that from the latter belongs to Mr. Joseph Wright, to whom I am indebted for the loan of it.)

GLYPHIOCERAS (SPHENOCERAS) CRENISTRIA, *J. Phillips*, sp. Plate XLII, fig. 5.

- | | | |
|----------|--|---|
| 1836. | GONIATITES CRENISTRIA, <i>J. Phillips</i> . | Geology of Yorkshire, pt. 2, p. 234,
pl. xix, figs. 7—9. |
| ? 1841. | — — — | Pal. Foss. Cornwall, Devon, and W.
Somerset, p. 121, pl. 1, figs. 234 a—g. |
| ? 1843. | — — — <i>F. A. Roemer</i> . | Verstein. Harzgeb., p. 33, pl. ix,
figs. 10 a, b. |
| — | — — — <i>J. Morris</i> . | Cat. Brit. Foss., p. 180. |
| 1842–44. | AMMONITES STRIATUS (pars), <i>L. G. de Koninck</i> . | Descrip. Anim. Foss. Terr.
Carb. Belgique, p. 568. |
| 1848. | GONIATITES CRENISTRIA, <i>J. H. Cumming</i> . | Isle of Man, p. 357. |
| — | — STRIATUS (pars), <i>H. G. Bronn</i> . | Gesch. d. Natur, vol. iii, p. 545. |
| 1850. | AGANIDES STRIATUS (pars), <i>A. d'Orbigny</i> . | Prod. de Paléont. stratigr., vol. i,
p. 115. |

1850. GONIATITES CRENISTRIA, *F. A. Roemer*. Palæont., vol. iii, p. 51, pl. viii, figs. 13 *a—c*; and Beitr. z. geol. Kenntn. nordwestl. Harzgeb., p. 51, pl. viii, figs. 13 *a—c*.
- 1850–56. — — (pars), *G. and F. Sandberger*. Verstein. rhein. Schichtensyst. Nassau, p. 74.
1852. AMMONITES SPHERICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 471.
- GONIATITES CRENISTRIA, *F. A. Roemer*. Beitr. zur geol. Kenntn. nordwestl. Harzgeb., pt. 2, p. 93, figs. 29 *a—c*.
1854. — — *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 303.
1855. AGANIDES SPHERICUS, var. β , CRENISTRIA, *F. McCoy*. Brit. Pal. Foss., p. 567.
- 1855–57. GONIATITES CRENISTRIA, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1870. — SPHERICUS, *F. Roemer*. Geol. Oberschlesien, p. 55, pl. vi, fig. 2.
1880. — STRIATUS (pars), *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 101.
1882. — CRENISTRIA, *C. Barrois*. Mém. Soc. géol. du Nord, vol. ii, No. 1, p. 292, pl. xiv, fig. 1.
1884. GLYPHIOCERAS CRENISTRIA, *A. Hyatt*. Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.
1888. GONIATITES CRENISTRIA, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 311.
1893. GLYPHIOCERAS CRENISTRIA, *A. Hyatt*. Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 471.
1894. — — — — — “Phylogeny of an Acquired Characteristic,” Proceed. Amer. Phil. Soc., vol. xxxii, p. 609.
1895. — — — — — *K. A. von Zittel*. Grundzüge der Palæont., p. 399.
1897. — — — — — *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Mus., pt. 2, p. 160, fig. 76 (suture-line).
- — — — — *James Perrin Smith*. “Development of Glyphioceras and the Phylogeny of the Glyphioceratidæ,” Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 113.
1898. — — — — — *G. C. Crick*. Trans. Linn. Soc., ser. 2, vol. vii, p. 106, pl. xx, figs. 15–18.
- cf. CRENISTRIA, *W. Wolterstorff*. Jahrb. d. Königl. Preuss. geol. Landesanst. u. Bergakad.: “Das Untercarbon von Magdeburg-Neustadt und seine Fauna,” p. 30, Taf. ii, figs. 7, 8, 18.

1903. GONIATITES CRENISTRIA, *Jas. Perrin Smith*. "The Carboniferous Ammonoids of America," U.S. Geol. Surv., Mon. xlii (pp. 1—211, 29 plates). Author's Abstract in Geologisches Centralblatt, Bd. iii, No. 13, p. 680.

Description.—"Shell subglobose; greatest thickness in the adult at a short distance from the margin of the umbilicus, in immature specimens at the margin of the umbilicus, about three-fifths of the diameter of the shell; height of outer whorl a little more than one-half of the diameter of the shell. Whorls six or seven; inclusion almost complete; umbilicus small, open, about one-tenth of the diameter of the shell in width. Whorl semi-elliptical in section, rather wider than high; indented to from one-half (in the young) to one-third (in the adult) of its height by the preceding whorl; periphery broadly convex; sides not very convex, rather flattened, the portion around the umbilicus prominent in the adolescent stage, slightly depressed in the adult; inner area imperfectly defined, in the cast almost at right angles to the plane of symmetry. Body-chamber occupying a complete whorl, aperture not seen. Chambers shallow, nineteen or twenty to a whorl. [Suture-line as in Pl. XLII, fig. 5.] Test thin, with fine, crenulated, feebly reticulated, curved, transverse striæ, which form a broad, forwardly concave sinus on the periphery; becoming almost smooth in the adult. Shell attaining a diameter of 66 mm." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Affinities.—The distinguishing feature of this species is the crenulation of the transverse striæ covering the test. In form it resembles *Glyphioceras striatus*, J. Sow., with which de Koninck has indeed united it, but its suture-line is quite distinct from the latter, and would in itself be a sufficient ground for separating the two species; the umbilicus is also smaller than that of *G. striatus*.

Remarks.—A well-preserved septate specimen, 38 mm. in diameter, with fragments of the test, is contained in the British Museum (Morris Collection, No. 50,183); this specimen is the one figured (Pl. XLII, fig. 5).

Phillips has recorded this species from Queen's County and the county of Fermanagh, as well as from Bolland, and the Isle of Man.

Localities.—Queen's County; county of Fermanagh. (The British Museum specimen cited above is labelled "Ireland" only.)

GLYPHIOCERAS (SPHENOCERAS) STRIATUM, *J. Sowerby*, sp. Plate XLIII, figs. 3, 4;
Plate XLIII, figs. 2 *a*, *b*.

1749. A beautiful NAUTILITES, *C. Lyttleton*. Phil. Trans., vol. xlv, p. 320, fig. 2.
1814. AMMONITES STRIATUS, *J. Sowerby*. Min. Conch., vol. i, p. 115, pl. liii,
fig. 1 (*not* Reinecke, *nor* Münster).
1825. GONIATITES STRIATUS, *G. de Hann*. Monog. Ammou. et Goniât., p. 159.
1828. ORBULITA STRIATA, *J. Fleming*. History of British Animals, p. 248.
1829. GLOBITES STRIATUS, *F. Holl*. Handb. Petrefact., p. 227.
1836. GONIATITES STRIATUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 233,
pl. xix, figs. 1—3.
— AMMONITES STRIATUS, *W. Buckland*. Geology and Mineralogy (Bridge-
water Treatise), vol. ii, p. 60,
pl. xl, fig. 2.
1838. — — *L. Agassiz*. In Desor's translation of Sowerby's
Mineral Conchology, vol. i, p. 27,
pl. xxvi.
1842-44. — — (pars), *L. G. de Koninck*. Descrip. Anim. Foss.,
p. 568, pl. xlix, figs. 7 *a*—*d*; pl. 1,
figs. 7 *a*—*c*.
1842. GONIATITES STRIATUS, *G. B. Sowerby*. Conch. Man., p. 309, fig. 480.
1843. — — *J. Morris*. Cat. Brit. Foss., p. 180.
— — *J. E. Portlock*. Geology of Londonderry, p. 407.
1844. — — *F. McCoy*. Synops. Carb. Foss. Ireland, p. 16.
? 1846. — SPHERICUS (pars), *F. A. Quenstedt*. Petrefact. Deutschl.,
vol. i (Cephalopoden), p. 66, pl. iii,
figs. 10 *a*—*d* (excl. fig. 11).
1848. — STRIATUS (pars), *H. G. Bronn*. Gesch. der Natur, vol. iii,
p. 545.
1850. AGANIDES STRIATUS (pars), *A. d'Orbigny*. Prod. de Paléont. stratigr.,
vol. i, p. 115.
1852. AMMONITES SPHERICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii,
p. 471.
1854. GONIATITES STRIATUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
1852-54. — SPHERICUS (pars), *F. Roemer*, in *H. G. Bronn's Lethæa*
Geogn., 3rd ed., vol. i, pt. 2, p. 517,
pl. i, figs. 17 *a*—*c*.
1855. AGANIDES SPHERICUS, var. γ , STRIATUS, *F. McCoy*. Brit. Pal. Foss., p. 567.
1855-57. GONIATITES STRIATUS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1864. — — *J. W. Salter*. Mem. Geol. Surv., Geology of the
Country around Oldham, p. 59.
1876. — SPHERICUS, *F. Roemer*. Lethæa Palæozoica, pl. xlvii, figs.
11 *a*—*c*.
— STRIATUS, *J. Armstrong, J. Young, and D. Robertson*. Cat.
Western Scottish Foss., p. 59.

1880. *GONIATITES STRIATUS* (pars), *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 101, pl. xlvi, figs. 1, 2; pl. xlvii, figs. 1, 2.
1883. — — *L. G. de Koninck*. Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.
1884. *GLYPHIOCERAS STRIATUM*, *A. Hyatt*. Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.
1888. *GONIATITES STRIATUS*, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 313.
1890. *GLYPHIOCERAS STRIATUM*, *G. Steinmann und L. Döderlein*. Elem. der Paläont., p. 393.
1893. — — *A. Hyatt*. Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 471.
1897. — — *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 166, fig. 78 (suture-line).
- — — *James Perrin Smith*. "Development of Glyphioceras and the Phylogeny of the Glyphioceratidae," Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 113.
1899. *GONIATITES STRIATUS*, *James Spencer*. Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, pt. 4, p. 391.
1901. (sens. str. in Haug) *STRIATUS*, *Collot*. "Goniatites carbonifères dans le Sahara" (Comptes rendus hebdomadaires des Séances de l'Académie des Sciences, tom. cxxxiii, p. 349).
- [Not 1818. *AMMONITES STRIATUS*, *Reinecke, Maris protogei Nautilus et Argonautas*, pl. viii, figs. 65, 66.—1839. *Goniatites striatus*, *G. Münster*, Beitr. zur Petrefactenk., i, p. 20.—1843. *Goniatites striatus*, *G. Münster*, ibid., i, 2nd ed., p. 46.—1843. *Goniatites striatus*, *F. A. Roemer*, Verstein. Harzgeb., p. 34, pl. ix, fig. 11.—1878. *Goniatites striatus*, *H. Abich*, Geol. Forsch. in den Kaukasischen Ländern, pt. 1, p. 9, pl. i, figs. 1—3; pl. xi, fig. 2.—1892. *Goniatites striatus*, *G. Wild*, Trans. Manchester Geol. Soc., vol. xxi, p. 364, pl. ii, fig. 11: "Lower Coal Measures of Lancashire," etc.]

Description.—"Shell subglobose, somewhat compressed, adult with eight sinuous constrictions feebly marked on the outer surface of the test, but very distinct on internal casts; greatest thickness at the margin of the umbilicus, five-eighths of the diameter of the shell; height of outer whorl rather more than three-sevenths of the diameter of the shell. Whorls six to eight; inclusion almost complete; umbilicus rather small, exposing the edges of the inner whorls, about one-sixth of the diameter in width. Whorl semilunate in section, wider than high; indented to nearly two-thirds of its height by the preceding whorl; periphery broadly convex; sides feebly convex, somewhat flattened; inner area nearly perpendicular to the plane of symmetry, slightly concave. Body-chamber occupying a complete whorl; aperture not seen. Chambers not very deep, about twenty in a whorl in an adult shell. [Suture-line as in Pl. XLII, fig. 3, and Pl. XLIII, figs. 2 *a*, *b*.] Test thin, with fine spiral striæ which in the adult shell are crossed by transverse sinuous incised lines forming a wide forwardly directed concave sinus on the periphery; it is thickened at intervals so as to produce well-marked constrictions on internal casts. ('Wrinkle-layer' composed of minute, coarse, wavy, anastomosing rugæ.) Shell attaining a diameter of 85 mm." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Affinities.—This species, though closely related to *G. sphaericum*, Martin, is distinguished therefrom by its more compressed form and by the spiral lines with which its test is ornamented; the suture-lines of the two species also differ somewhat from each other.

Remarks.—Owing probably to the absence of the test, or to other defects, this species has sometimes been mistaken for *Glyphioceras sphaericum*, Martin, as may be seen by looking at the list of references above. It seems to be rare in Ireland; Phillips has no record for it there, and McCoy ('Synopsis') has only one, nor does he figure the species. The specimens at my disposal are all more or less crushed fragments, but the sutures and ornamentation are well preserved, and this has made the recognition of the species possible. There being no illustrations of the species in any work treating of Irish fossils, I have figured in Pl. XLIII a fine specimen from Derbyshire contained in the British Museum, in addition to those imperfect ones from the black shale figured in Pl. XLII.

Localities.—Courtclough, Garristown, and Newton, county of Dublin; Drumsra, near Drumquin, county of Tyrone (Sir R. Griffith's 'Localities of the Irish Carboniferous Fossils,' added in 1862 to McCoy's 'Synopsis').

Sub-genus BEYRICHOCERAS,¹ sub-gen. nov.

GLYPHIOCERAS (BEYRICHOCERAS) OBTUSUM, *J. Phillips*. Plate XLII, figs. 7—9.

1813. ELLIPSOLITES OVATUS, *J. Sowerby*. Min. Conch., vol. i, p. 83, pl. xxxvii (imperfectly defined).
1822. NAUTELLIPSITES OVATUS, *J. Parkinson*. Introd. Foss. Org. Rem., pp. 164 and 233.
1825. GONIATITES OVATUS, *G. de Hann*. Monogr. Ammon. et Goni., p. 148.
1829. GLOBITES OVATUS, *F. Holl*. Handb. der Petrefactenkunde, p. 226.
1836. GONIATITES OBTUSUM, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 10, 11, ? 13 (not fig. 12 = GLYPHIOCERAS PHILLIPSI, *Foord* and *Crick*, Cat. Foss. Ceph. British Museum, 1897, p. 172).
- 1838 45. NAUTILUS OVATUS, *L. Agassiz*. In Desor's translation of Sowerby's Mineral Conchology, vol. i, pp. 27 and 65, pl. xxxvii.
1843. GONIATITES OBTUSUM, *J. Morris*. Cat. Brit. Foss., p. 180.
1844. — — *F. McCoy*. Synops. Carb. Foss. Ireland, p. 15.
1848. — — *J. H. Cumming*. Isle of Man, p. 357.
- — — (pars), *H. G. Bronn*. Gesch. der Natur, vol. iii, p. 543.
1849. — — *T. Brown*. Illustr. Foss. Conch. of Great Britain and Ireland, p. 28, pl. xxi, figs. 11, 12.
1850. AGANIDES OBTUSUM, *A. d'Orbigny*. Prod. der Paléont. stratigr., vol. i, p. 115.
1852. AMMONITES SPHERICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 471.
1854. GONIATITES OBTUSUM, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
- 1855-57. — — *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1878. — — *G. A. Lebour*. Geology of Northumberland, p. 67.
1880. — — *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 104, pl. xlvii, fig. 3; pl. xlvii, fig. 10.
1883. — — *L. G. de Koninck*. Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.
- GLYPHIOCERAS OBTUSUM, *A. Hyatt*. Proceed. Boston Soc. Nat. Hist., vol. xxii, p. 329.
1888. GONIATITES OBTUSUM, *R. Etheridge*. Brit. Foss., vol. i, Palaeozoic, p. 312.
1897. GLYPHIOCERAS OBTUSUM, *A. H. Foord* and *G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 169, fig. 79 (suture-line).
1899. GONIATITES OBTUSUM, *James Spencer*. Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, p. 391.

¹ For definition of this sub-genus see Appendix, p. 219.

Description.—Shell subglobose, involute, slightly compressed on the sides which are feebly convex and subparallel; greatest thickness at the umbilical margin, about four-sevenths of the diameter of the shell; height of outer whorl about one-half of the diameter of the shell. Inclusion of whorls almost complete; umbilicus very small and infundibuliform in the young shell, closed in the adult, with rounded margin. Whorl semi-elliptical in section, height about five-sixths that of the width; indented to about one-half its height by the preceding whorls. Periphery broadly rounded, with a tendency to flattening in the adult shell near the extremity of the body-chamber; inner area very narrow. Body-chamber occupying at least an entire whorl. Chambers not very deep, about fourteen in a whorl; suture-line as in Pl. XLII, figs. 7 *c*, 8 *c*. Test nearly smooth, ornamented with very fine sinuous lines of growth, which are strongly arched forward near the periphery, and form on the latter a deep and broad sinus; they are sometimes accompanied by narrow, obscure folds. One or two broad and shallow constrictions are generally present, especially in adult shells.

Dimensions.

	Uncompressed, but slightly elliptical specimen from Midleton, near Cork.	Elliptical specimen from Little Island, in Mr. Joseph Wright's Collection.
Diameter of shell	55 mm.	73 mm.
„ „ umbilicus	9 „	5 „
Height of outer whorl	27 „	31 „
„ „ above preceding whorl	19 „	20 „
Thickness at umbilical margin	32 „	37 „

Owing to distortion in both specimens these measurements are only approximate.

Affinities.—Mr. G. C. Crick and the author of this monograph have shown elsewhere¹ that Phillips had included two distinct species under the name “*Goniatites obtusus*”; the original of Phillips’s pl. xix, fig. 10, was selected as the type of *Glyphioceras obtusum*, and the specimen represented by fig. 12 was separated from the former under the name of *Glyphioceras Phillipsi*. The differences which distinguish the two species are the following:—*G. (B.) Phillipsi* has a more compressed form and a more prominent umbilical margin than *G. (B.) obtusum*, and thus it resembles *G. (B.) diadema*, Beyr., while its suture-line distinguishes it from *G. (B.) micromotum*, to which it is also related. I have not recognised *G. Phillipsi* among the Irish fossils; the type is in the “Gilbertson Collection” in the British Museum (Register No. C. 5099 *a*), but the locality is unfortunately unknown. *G. (B.) obtusum* is distinguished from *G. (B.) subtruncatum* by its much thicker shell, its rounded periphery, and its suture-line, and in the latter character it differs materially from *G. (B.) occidentale* (p. 170).

¹ Cat. Foss. Ceph. British Museum, pt. 3, p. 169.

Remarks.—The specimens of this species that have come under my notice, though much larger than any previously recorded, are unfortunately for the most part much distorted. They come chiefly from the Cork and Limerick districts. None have been found to my knowledge in the county of Dublin or Kildare. Phillips's figured type came from Bolland in Lancashire, but the first individuals described belonging to this species were collected at Blackrock, in the county of Cork; these were described by J. Sowerby ('Min. Conch.,' i, p. 83) under the name of *Ellipsolites ovatus*, the generic name having been suggested by the ellipticity of the shells, which was assumed by Sowerby to be natural, instead of being artificially produced by rock pressure as was subsequently recognised.

Localities.—Little Island and Middleton, county of Cork; Ballyduff (Dungarvan), county of Waterford; Ballynacarriga, county of Limerick.

GROUP OF GLYPHIOCERAS (BEYRICHCERAS) TRUNCATUM.

GLYPHIOCERAS (BEYRICHCERAS) TRUNCATUM, *J. Phillips*, sp. Plate XLIII, figs. 5 *a, b*; Plate XLIV, figs. 1—4; Plate XLV, figs. 1 *a—d*, 2 *a—c*; Plate XLIX, fig. 14.

1836. GONIATITES TRUNCATUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 223, pl. xix, figs. 20, 21.
1843. NAUTILUS PERPLANATUS, *J. E. Portlock*. Geology of Londonderry, p. 403, pl. xxix A, fig. 11.
- GONIATITES TRUNCATUS, *J. Morris*. Cat. Brit. Foss., p. 180.
1844. — — *F. McCoy*. Synops. Carb. Foss. Ireland, p. 16.
1848. — — *J. H. Cumming*. Isle of Man, p. 357.
- — *H. G. Bronn*. Gesch. der Natur, vol. iii, p. 545.
1850. AGANIDES TRUNCATUS, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 115.
1852. AMMONITES TRUNCATUS, *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 474.
1854. GONIATITES TRUNCATUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 305.
- NAUTILUS PERPLANATUS, *J. Morris*. Ibid., p. 308.
- 1855–57. GONIATITES TRUNCATUS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1862. — — *R. Griffith*. Ibid., vol. ix, p. 56.
1864. — — *J. W. Salter*. Mem. Geol. Surv., Geology of the Country around Oldham, p. 59.
1878. — TRUNCATUS, *G. A. Lebour*. Geology of Northumberland, p. 68.
1880. — — *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 108, pl. xlvi, fig. 5; pl. xlviii, figs. 1—3; pl. xlix, fig. 7; pl. l, fig. 2.
1883. — — *L. G. de Koninck*. Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.

1883. *MUNSTERO CERAS TRUNCATUM*, *A. Hyatt*. Proc. Boston Soc. Nat. Hist., vol. xxii, p. 326.
1888. *GONIATITES TRUNCATUS*, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 313.
1889. *GLYPHIO CERAS TRUNCATUM*, *E. Holzappel*. Palæont. Abhandl., Dames und Kayser, vol. v, i, p. 26, pl. i, figs. 8, 9.
1890. *MUNSTERO CERAS TRUNCATUM*, *G. Steinmann und L. Döderlein*. Elemente der Palæontologie, pt. 2, p. 393.
1895. *GONIATITES TRUNCATUS*, *G. H. Morton*. Proc. Liverpool Nat. Field Club for 1894, p. 24.
1897. *GLYPHIO CERAS TRUNCATUM*, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 175, fig. 82 (suture-line).
1898. — — — *G. C. Crick*. Trans. Linn. Soc., ser. 2, vol. vii, p. 108, pl. xx, fig. 19.
- 1900–1901. *GONIATITES TRUNCATUS*, *G. H. Morton*. “The Carboniferous Limestone of Anglesey,” Proc. Liverpool Geol. Soc., p. 52.
1903. *GLYPHIO CERAS TRUNCATUM*, *Wheelton Hind*. Brit. Assoc. Adv. Sci., Belfast, 1902, p. 215: “Life-zones in the Carboniferous Rocks.”
- [Not 1854. *Goniatites truncatus*, *F. A. Roemer*, Palæontographica, vol. iii, p. 94, pl. xiii, fig. 30.—
1884. *Glyphioceras truncatum*, *A. Hyatt*, Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.]

Description.—Shell attaining a considerable size, much compressed, discoidal, involute; the greatest thickness at about one-third of the height of the whorl from the edge of the umbilicus, rather more than one-third of the diameter of the shell; height of outer whorl three-fifths of the diameter of the shell. Whorls from five to six; inclusion nearly complete; umbilicus small, shallow, from one-seventh to one-ninth of the diameter of the shell in width. Whorl subquadrangular in section, about one-third higher than wide; indented to nearly one-third of its height by the preceding whorl. Periphery more or less flattened or subtruncate, sometimes with perceptible subangular margins; sides very slightly convex, flattened; umbilical zone scarcely distinguishable, gently rounded, merging into the sides of the shell. Body-chamber occupying rather more than a complete whorl; aperture with a deep lateral, and a deep peripheral sinus. Chambers rather deep, eleven or twelve in a whorl; suture-line as in Pl. XLIV, fig. 2 *c*, and Pl. XLIX, fig. 1-4.

Test thin, with fine sigmoidal lines of growth which become obsolete in large adult specimens. A few constrictions, sometimes strong, sometimes feeble, are present in all stages of growth (Pl. XLIII, fig. 5; Pl. XLIV); these are broad and shallow, and occur apparently at irregular intervals; they are very conspicuous upon the cast, but are scarcely seen upon the test, which seems to fill them up almost entirely. In a very large adult shell, the surface of which is much eroded, there are obscure transverse folds near the aperture representing the lines of growth, and these are seen in other specimens, large and small, under favourable conditions of preserva-

tion, casts sometimes exhibiting them. The shell is for the most part, however, quite smooth.

Dimensions.

		Specimens in the Museum of Science and Art, Dublin. Geol. Surv. Coll. Lismakerry (No. 4124).		General Coll. Clanc.	
Diameter of shell	.	112	mm.	90	mm.
„ umbilicus (edge to edge)	.	20	„	17	„
„ „ (suture to suture)	.	15	„	13	„
Height of outer whorl	.	55	„	46	„
„ above preceding whorl (about)	.	29	„	(about) 20	„
Thickness of shell at umbilical margin	.	39	„	30	„

These dimensions bring out very clearly the flatness of the shell in this species, its most conspicuous feature, and the one by which it is most easily recognised.

Affinities.—It is quite evident that this species is closely connected with the one described under the name of *Glyphioceras (Beyrichoceras) subtruncatum* (p. 168). It differs from this in being flatter in form and in the possession of a smaller umbilicus; the truncation of the periphery appears to be equally strongly marked in the two species, and to vary in degree in different individuals. The surface markings are the same in both species, the distinctness of the transverse lines depending very much upon the state of preservation of the shell. Under favourable conditions they constitute in the present species a fairly distinct ornamentation. The constrictions do not in any case constitute a remarkable feature, except in some very young individuals; they are only seen upon the cast, as the test completely covers them. Taking the character of the suture-line into account, it appears that the chambers are somewhat shallower in *G. (B.) truncatum* than they are in *G. (B.) subtruncatum*.

Remarks.—The brief description of this species given by Phillips runs as follows:—"Very depressed, back (in adults) truncate; umbilicus open; fine transverse bent striæ." The type specimen being preserved ("Gilbertson Collection," British Museum), the identity of the species was secured, though the feature upon which the author founded it, the truncation of the periphery, is not always so conspicuous as it might be judged to be according to Phillips's figure ('Geol. Yorks,' pl. xxix, fig. 21). Among the specimens before me the distinctness of the peripheral flattening varies in different individuals, and while in some it is quite apparent in others it is scarcely discernible. This variability, however, does not deprive the species of its individuality, its compressed form, as already stated, supplying the principal specific feature.

Glyphioceras (Beyrichoceras) truncatum is one of the most common and most widely distributed of the Carboniferous Goniatites in Ireland; it varies considerably in size, and to some extent in thickness, some individuals being much more com-

pressed than others. The flattening of the periphery and the compressed form of the shell are, however, the distinguishing marks of the species, making due allowance for local variability.

Taking the present species as the typical form, the following species added to it make up the group of *G. (B.) truncatum*:—*G. (B.) subtruncatum*, *G. (B.) occidentale*, *G. (B.) difficile*, *G. (B.) subquadratum*.

In the supplementary plate (Pl. XLIX, fig. 14) will be seen the suture-line of the present species taken at a point remote from the body-chamber, and therefore probably representing the chambers at their normal distance apart. Fig. 2 *c* of Pl. XLIV, on the other hand, depicts the last three septa, which, as is so commonly the case, are somewhat nearer together. The peripheral lobe in this figure was defective in the specimen, and it is represented much too narrow. Fig. 14 on Pl. XLIX is taken from a specimen about 90 mm. in diameter belonging to the Museum of the Royal College of Science for Ireland, Dublin, kindly lent to the author by Professor Grenville A. J. Cole, M.R.I.A., F.G.S.

Localities.—Drumscra (Drumquin), county of Tyrone; St. Doulagh's, county of Dublin; Clane, county of Kildare; Ballyduff (Dungarvan), county of Waterford; Little Island, Tankardstown (Kildorrery), and Middleton, county of Cork; Lisnakerry, Nantenan, Ballycahane, and Kilmacat, county of Limerick.

GLYPHIOCERAS (BEYRICHCERAS) SUBTRUNCATUM, sp. nov. Plate XLV, figs. 3 *a—d*,
4 *a—c*.

Description.—Shell of medium size, discoid, somewhat compressed, composed of from six to seven whorls (?); the greatest thickness at about one-fourth of the height of the whorl from the edge of the umbilicus, about three-sevenths of the diameter of the shell; height of outer whorl about four-sevenths of the diameter of the shell. Inclusion of the whorls nearly complete; umbilicus small in the young and adolescent stage of growth, but proportionately larger in the adult. Whorl subquadrangular in section, about one-third higher than wide, indented to about one-third of its height by the preceding whorl. Periphery about one-third of the height of the outer whorl in width, more or less perceptibly flattened; umbilical zone indistinct, gently convex, merging in the sides of the shell. Body-chamber occupying rather more than an entire volution; aperture, so far as may be judged by the lines of growth, with a prominent crest in young individuals (Pl. XLV, fig. 4 *a*), which becomes somewhat less strongly marked in older ones. Chambers moderately deep, apparently sixteen or seventeen to a whorl. Suture-line as in Pl. XLV, fig. 3 *d*.

Test thin for the most part, but becoming thicker in the umbilical region, having

faint lines of growth which on leaving the umbilicus curve forwards, then a little backwards, and again more prominently forwards so as to form a crest just below the periphery. One or two shallow constrictions are seen upon the cast, but the test when present quite conceals them.

Dimensions.

	Specimen in the Museum of Science and Art, Dublin (Geological Survey Coll.). Nanteman.
Diameter of shell	70 mm.
„ umbilicus (edge to edge)	7 „
Height of outer whorl	39 „
„ above preceding whorl (about)	19 „
Thickness of shell at umbilical margin	30 „

By comparing these measurements, taken from an undistorted specimen, with those of *Glyphioceras* (*Beyrichoceras*) *truncatum* (p. 167), the greater thickness of the shell in the present species becomes apparent.

Affinities.—On comparing the figures of this species with those of *Glyphioceras* (*Beyrichoceras*) *truncatum*, the chief resemblance between the two will be clearly seen. Both of them have the peripheral flattening more or less strongly emphasised in the adult shell, and there is a similarity in the umbilical characters, smoothness of the test, etc.; but in the present species the shell is much thicker and more inflated, and it is upon this character that the main distinction between the two species is based. The peripheral lobe of the suture-line is also both broader and deeper in *G. (B.) subtruncatum* than it is in *G. (B.) truncatum*, its greater breadth naturally corresponding with the superior breadth of its peripheral area. *G. (B.) inconstans*, de Kon.,¹ is another species which will very well bear comparison with *G. (B.) subtruncatum*, and de Koninck points out its resemblance also to *G. (B.) truncatum*. It differs from both in the greater size of its umbilicus in the adult stage of growth and in the regular constrictions which occur in the young shell (De Koninck, loc. cit., pl. xlviii, fig. 1). The larger size and angular margin of the umbilicus in *G. inconstans* are the most striking differences between this species and *G. subtruncatum*.

The present species differs from *G. obtusum* in its more slender habit, in the truncation or less broadly rounded character of the periphery, and in the structure of the suture-line.

Remarks.—This species has so far been found chiefly in the south and south-west of Ireland, in the counties of Tipperary and Limerick.

¹ Faune Cal. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 120, pl. xlviii, figs. 4—9.

Localities.—Clonmel, county of Tipperary (from Mr. Joseph Wright's collection); Ballynacarriga (Nos. 301, 778, and 1519 of the Geol. Surv. Coll.), Nantenan (Nos. 259 and 4712), and Fanningtown (No. 1141), county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) OCCIDENTALE, sp. nov. Plate XLV, figs. 5 *a*, *b*,
6 *a*, *b*.

Description.—Shell of medium size, discoid, somewhat compressed, close-coiled, the greatest thickness at about one-third of the height of the whorl from the umbilicus, about one-half of the diameter of the shell; height of the outer whorl about five-sixths of the diameter of the shell. Inclusion of the whorls nearly complete; umbilicus small. Whorl semi-elliptical in cross-section, about one-fourth higher than wide, indented to nearly half its height by the preceding whorl. Periphery rounded. Umbilical zone indistinct, merging with a very slight convexity in the sides of the shell. Body-chamber occupying at least one entire whorl; aperture, as indicated by the lines of growth, with a shallow hyponomic sinus upon the periphery and a somewhat prominent crest upon the upper third of the lateral margin. One or two shallow constrictions occur, marked only upon the cast. Chambers somewhat deep as seen in the rather widely spaced suture-lines (Pl. XLV, fig. 5 *c*), the peripheral lobe large as compared with the lateral lobe. Test almost smooth, the lines of growth pursuing the direction taken by the outline of the aperture just described.

Dimensions.

	Specimens from Kerry in the Museum of Science and Art, Dublin (Geological Survey Collection).	
	(No. 4169.)	(No. 3786.)
Diameter of shell . . .	55 mm.	43.0 mm.
„ umbilicus . . .	9 „	5.0 „
Height of outer whorl . . .	30 „	21.5 „
„ above preceding whorl . . .	15 „	9.0 „
Thickness at umbilical margin . . .	28 „	19.0 „

Affinities.—This species resembles *G. (B.) rotella*, de Kon.,¹ in many particulars, and I should have hesitated to separate them but for the much larger umbilicus of the latter. The sutures are remarkably similar to each other in form in the two species, though de Koninek gives no information as to their distance

¹ Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 106, pl. xlix, figs. 14, 14 *a*.

apart in *G. rotella*. The rotundity of the periphery and the smoothness of the test are the same in both species. *G. (B.) complanatum*, de Koninck,¹ bears also some resemblance to the present species, but it is a more slender shell and the septa are much closer together. The smooth test, rounded periphery, more inflated sides, and distant septa distinguish the present species from *G. (B.) subtruncatum*, though in spite of these differences, which are rather of degree than of kind, the resemblance between the two species cannot fail to be observed.

Remarks.—The specific name given to this species refers to the localities whence it was obtained, being in the western part of Ireland.

Localities.—Ballinacarriga, county of Limerick (301 C., 1519 C.); Garrihies, county of Kerry (661 C., 3786 C., 4169 C.).

GLYPHIOCERAS (BEYRICHCERAS) DIFFICILE, sp. nov. Plate XLVI, figs. 1 *a—c*.

Description.—Shell (cast) discoid, thick, somewhat compressed, the greatest thickness at the umbilical margin. Owing, however, to a peculiar distortion of the shell whereby the upper half is shifted sideways in relation to the lower half along a line bisecting the shell diagonally, this measurement cannot be given accurately, but it represents rather less than one-half of the diameter of the shell; height of the outer whorl somewhat less than three-fifths of that diameter. Inclusion of the whorls nearly complete; umbilicus small. Whorl subsagittate in cross-section, somewhat higher than wide. Periphery rather narrowly rounded. As the fragment described is entirely septate, nothing is known of the body-chamber, Chambers rather shallow. Suture-line as in Pl. XLVI, fig. 1 *c*. Test unknown, the fragment that remains being too much eroded to show any trace of ornamentation.

Dimensions.

Specimen in the Museum of Science and Art, Dublin (Geological Survey Collection).			
Diameter of shell (cast) (about)	.	.	76 mm.
„ umbilicus (about)	.	.	10 „
Height of outer whorl (about)	.	.	42 „
Thickness at umbilical margin (about)	.	.	33 „

Affinities.—Both in its general form and in the conformation of its suture-line the present species bears a very striking resemblance to *Glyphioceras Hispanicum*, Foord and Crick,² and perhaps with better material the identity of the two species

¹ Loc. cit., pl. xlv, figs. 4, 4 *a*.

² 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, p. 190, figs. 91 *a—c*.

might have been established. On the other hand, the numerous constrictions sometimes present in *G. Hispanicum* appear to be entirely wanting in *G. difficile*, which has also a thicker shell. On the whole it seemed better to give a distinctive name to the Irish species rather than to merge it in the Spanish one upon the imperfect information available.

Glyphioceras (*Beyrichoceras*) *difficile* may, however, very appropriately take its place in the group of *G. (B.) truncatum* and its allies. The difficulty I have experienced in separating the forms included in this group is in itself a measure of their very close affinities.

Locality.—Lisnakerry, county of Limerick.

GLYPHIOCERAS (BEYRICHCERAS) SUBQUADRATUM, sp. nov. Plate XLVI, figs. 2 *a*—*c*.

Description.—Shell discoidal, compressed, sides moderately convex, the periphery distinctly flattened, with well-defined lateral angles; umbilicus rather large, deep; umbilical zone narrow, nearly perpendicular, the edges subangular. Inner whorls exposed only at their edges; inclusion nearly complete. Whorl subquadrate in section owing to the marked truncation of the periphery; greatest thickness at the umbilical margin, a little more than five-sevenths of the height. Suture-line as in Pl. XLVI, fig. 2 *c*. Test, seen in a young individual, ornamented with extremely fine imbricating (?) striæ, which form a gentle sigmoidal curve in crossing the sides of the shell, and a deeply indented sinus in crossing the periphery. Several shallow constrictions are present on the east.

Dimensions.

	Specimen from Little Island, Cork, in the Bristol Museum.		
Diameter of shell (longer)	.	.	78 mm.
" " (shorter) (about)	.	.	50 "
" of umbilicus (longer)	.	.	20 "
" " (shorter)	.	.	17 "
Height of outer whorl	.	.	35 "
Thickness at umbilical margin	.	.	28 "

From these dimensions it will be seen that the specimen measured has been distorted into an elliptical shape, and this is precisely the case with another specimen from the same locality from which the suture-line (Pl. XLVI, fig. 2 *c*) has been drawn.

Affinities.—Notwithstanding the much greater size of the umbilicus in this species compared with that which is met with in species belonging to the group

of *Glyphioceras truncatum*, the resemblance to this series in other features is noteworthy, especially in the flattened sides and truncated periphery. The suture-line also is not very dissimilar, comparing together, *e. g.*, the suture-line of *G. difficile* with that of *G. subquadratum* (Pl. XLVI, figs. 1 *c* and 2 *c*).

Remarks.—The specimen from which the above description was chiefly drawn up having come unexpectedly into my hands after the plates had all been printed, I have not been able to figure it; the one referred to at the head of this description must therefore suffice to represent it, and it in fact gives all essential features, the details of the umbilicus being alone deficient; these are supplied by the recently available specimen. The latter thus fulfils the double office of amplifying structural details, and of confirming the existence of a specific form whose validity might, upon the evidence of a single specimen, have been called in question.

Locality.—Little Island, near Cork.

GLYPHIOCERAS (BEYRICHCERAS) SPHÆROIDALE? *McCoy*. Plate XLVI, figs. 3 *a, b*;
5 *a, b*.

1844. GONIATITES SPHÆROIDALIS, *F. McCoy*. Synops. Carb. Foss. Ireland, p. 15,
pl. iv, fig. 18.
1850. AGANIDES SPHÆRICUS (pars), *A. d'Orbigny*. Prod. de Paléont. stratigr.,
vol. i, p. 115.
1852. AMMONITES SPHÆRICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, Bd. iii.
Abth. i, p. 471.
1854. GONIATITES SPHÆROIDALIS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
1862. — — — *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix,
p. 55.
1880. — — — *L. G. de Koninck*. Faune Calc. Carb. Belgique
(Ann. Mus. Roy. d'Hist. Nat. Belgique,
sér. Paléont., tom. v), pt. 2, p. 99,
pl. xlvii, figs. 6, 7; pl. xlviii, figs. 10–12.
1889. GLYPHIOCERAS SPHÆROIDALE, *E. Holzappel*. Palæont. Abhandl., Dames
und Kayser, Bd. v, i, p. 30.
1897. — — — *A. H. Foord and G. C. Crick*. Cat. Foss.
Ceph. British Museum, pt. 3, p. 183.

Description.—Shell spheroidal, somewhat compressed laterally, rather widely umbilicated; greatest thickness at the margin of the umbilicus, about four-sevenths of the diameter of the shell, height of outer whorl about three-sevenths of that diameter. Number of whorls unknown. Inclusion fully three-fourths. Umbilicus probably of moderate depth, but not fully available for examination. Whorl semi-lunate in section, nearly twice as wide as high, indented to about three-fourths of

its height by the preceding whorl; sides somewhat flattened, peripheral area very distinctly flattened in the young shell with a fairly well-marked rounded margin.

Body-chamber not seen. The suture-line is described but imperfectly figured by M'Coy (loc. cit.); it is, however, figured by de Koninck (loc. cit., p. 99). Test ornamented with fine transverse lines of sigmoidal form crossed by faint longitudinal ridges both upon the sides and the peripheral area. A series of very narrow and shallow constrictions are developed, about ten to a whorl; these proceed from the region of the umbilicus with a slight, backwardly directed curve and cross the peripheral area, making upon it a broad, backwardly directed sinus and a well-marked angle at its margin on each side (Pl. XLVI, fig. 5 a).

Dimensions.

				Young shell from Ballinacarriga in the Dublin Museum of Science and Art (Geological Survey Collection). (No. 255.)
Diameter of shell	.	.	.	35.0 mm.
„ umbilicus	.	.	.	10.0 „
Height of outer whorl	.	.	.	15.5 „
„ above preceding whorl	.	.	.	8.0 „
Thickness at umbilical margin	.	.	.	22.5 „

Affinities.—This species is distinguished from *G. Browni*, M'Coy (p. 175), by its smaller umbilicus, more inflated form, and by its ornamentation. It agrees well in respect to the latter feature with de Koninck's specimens as figured by him (loc. cit.), though the umbilicus in the Irish specimens is a little smaller. M'Coy gives only one figure of this species, a lateral view, and therefore the peripheral flattening so well marked in the specimen from Ballinacarriga (Pl. XLVI, fig. 5) is not exhibited. The present species differs both in sutural characters and in ornamentation, as well as in the flattening of the periphery, from *G. (B.) sphaericum*.

Remarks.—A specimen (Pl. XLVI, fig. 3) from Kilmallock (county of Limerick), contained in the "Griffith Collection," has the name of this species written upon the tablet on which it is mounted, and it has been doubtfully referred to M'Coy's type (loc. cit.), but if it be this M'Coy's figure is inaccurate, as the umbilicus is represented as being much larger than it is in the specimen. The figure also shows a part of the suture-line upon the last whorl, whereas no trace of this is seen upon the specimen. On the whole, however, it appears to belong to the species to which it has been assigned, viz. *G. (B.) sphaeroidale*.

Localities.—Ballyrichard, county of Cork (No. 4767—Dublin Museum of Science and Art, Geological Survey Collection); Kilmallock and Ballinacarriga, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) BROWN? *F. McCoy*, sp. Plate XLVI, figs. 4 *a-c*.

1844. GONIATITES BROWN, *F. McCoy*. Synops. Carb. Foss. Ireland, p. 12, pl. iv, fig. 17.
 1880. — *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 98.
 1889. GLYPHIOCERAS BROWN, *E. Holzapfel*. Paläont. Abhandl., Dames und Kayser, Bd. v, i, p. 30.
 1897. — — *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 183.
 1899. — — *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 438.

Description.—The following is McCoy's description:—"Discoid, subglobose, sides flattened; umbilicus large, acute-edged, exceeding one-third the diameter of the shell; surface smooth; septa, dorsal lobe small, bifid; dorsal sinus acute; first lateral lobe slightly exceeding the dorsal in length, very wide, rounded; lateral sinus twice as long as the dorsal, acute, linguiform; second lateral lobe very wide, obtusely rounded.

"From the *G. striatus*, Sow., which the species most resembles, it is distinguished internally by its much shorter and wider first lateral lobe; the same character distinguishes it from the *G. sphaericus*, Sow., and from both it is distinguished externally by its smooth surface, and from all the species of the same form by the large size of the umbilicus. Diameter two inches two lines; thickness one inch one line."

Remarks.—The type of this species has been lost, and there is therefore only McCoy's figure and description to serve for its identification. A distorted specimen bearing the name "*Goniatites sphaeroidalis*" is contained in the "Griffith Collection," and this I refer with considerable doubt to McCoy's species. To give its dimensions would be misleading, as its original form has been converted by pressure into a long ellipse. The principal ground for the determination of its affinities rests upon the size of the umbilicus, which, as in McCoy's representation of the species, is remarkably large, being approximately one-half of the shorter diameter of the shell and about one-third of the longer. The suture-line is too imperfect for comparison with the one figured by McCoy (loc. cit.), otherwise it would have afforded very important information. The test, which is not well preserved, bears upon its surface a few faint longitudinal ridges and

concentric lines of growth, which form a deep and wide hyponomic sinus upon the periphery.

The name of this species does not occur in Sir R. Griffith's list of localities appended to M'Coy's 'Synopsis' (1862), but the tablet is inscribed "Co. Limerick -- Presented by Sir R. Griffith, Bart."

Locality.—County of Limerick (exact locality unknown).

GLYPHIOCERAS (BEYRICHCERAS) CORPULENTUM, *G. C. Crick*. Plate XLVII, figs. 1 *a*, *b* ;
Plate XLVIII, figs. 1 *a*—*c*.

1899. GLYPHIOCERAS CORPULENTUM, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7,
vol. iii, p. 447, fig. 12.

Description.—Shell much inflated, the greatest thickness at the umbilical margin, about three-fifths of the diameter of the shell; the height of the outer whorl nearly one-half of the same. Whorls few, their number not determinable from the specimens available; inclusion nearly complete owing to the greatly expanded sides of the shell; umbilicus deep, with subangular margin and precipitous sides; about three-tenths of the diameter of the shell in width. Whorl sublunate in cross-section; the height about three-fourths of the width; indented to nearly one-half of its height by the preceding whorl. Periphery broadly convex, imperfectly defined; merging in the inflated sides. Umbilical zone distinctly defined, narrow, nearly perpendicular to the plane of symmetry of the shell.

Body-chamber occupying nearly the whole of the last whorl; aperture not preserved, but the lines of growth indicate the presence of a slight crest near the edge of the umbilicus, and a very wide and shallow hyponomic sinus. Chambers shallow; suture-line as in Pl. XLVIII, fig. 1 *c*.

Test ornamented with fine, subregular, raised lines, which become more distinct in the adult shell; these extend obliquely and abruptly backwards from the umbilical margin and form a very wide and shallow sinus upon the periphery. The latter bears some widely spaced, faintly defined longitudinal bands in the adult; in the young shell these bands extend to the sides of the shell; though not a very conspicuous feature, these longitudinal bands give a certain distinguishing character to the ornamentation of the shell when viewed in connection with the transverse lines, and as they persist throughout the growth of the shell they are of definite value as specific data.¹ The cast in the adult individual shows near the aperture two wide and shallow but quite conspicuous constrictions, and there are indications of similar features in the young shell.

¹ The lithographer has omitted the longitudinal bands in the figures of the young shell (Pl. XLVIII, figs. 1 *a*, *b*).

Dimensions.

	Specimens in the Museum of Science and Art, Dublin.	
	Adult specimen (type).	Young specimen.
Diameter of shell	95 mm.	65.0 mm.
„ umbilicus (edge to edge)	25 „	20.0 „
„ „ (suture to suture)	22 „	15.5 „
Height of outer whorl	45 „	27.0 „
„ above preceding whorl	25 „	18.0 „
Thickness at umbilical margin (about)	58 „	40.5 „

Affinities.—In his description of this species Mr. Crick has not ventured to suggest any comparison of it with others, and it is in fact difficult to institute any satisfactory one, so distinct does its principal feature prove to be, that is, the extremely globose form of its whorls. In considering its affinities in a more comprehensive sense the character of the suture-line indicates these to be with *Beyrichoceras* rather than *Münsteroeras*. The suture-line of *G. (B.) truncatum* (Pl. XLIV, fig. 2 c, and Pl. XLIX, fig. 14), *e. g.*, is not unlike that of the present species, and there is another feature in which these species resemble each other, and that is in the possession of broad and very shallow constrictions¹ at irregular intervals on the surface of the cast.

Remarks.—Only three specimens of this species are known to me, the two figured on Pls. XLVII and XLVIII, from which Mr. Crick drew up his description of the species, and another smaller one which passed through my hands; all are from the same place.

Locality.—St. Doulagh's, county of Dublin.

GLYPHIOCERAS (BEYRICHCERAS) MICRONOTUM, *J. Phillips*, sp. Plate XLIV, figs. 5 a, b.

1836. GONIATITES MICRONOTUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 22, 23.
 1843. — — *J. Morris*. Cat. Brit. Foss., p. 180.
 1844. — — *F. McCoy*. Synops. Carb. Foss. Ireland, p. 14.
 1848. — — *J. H. Cumming*. Isle of Man, p. 357.
 — — *H. G. Bronn*. Gesch. der Natur, vol. iii, p. 543.
 1850. AGANIDES MICRONOTUS, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 115.
 1852. AMMONITES MICRONOTUS, *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 474.

¹ Two of these are seen close together on the specimen figured on Pl. XLVII, fig. 1 a, at the upper part of the latter.

1854. GONIATITES MICRONOTUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
 1855-57. — — — *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
 1880. — — — *W. Branco*. Palæontographica, vol. xxvii, p. 24, pl. iv, fig. iv a-l.
 1883. GLYPHIOCERAS MICRONOTUM, *A. Hyatt*. Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.
 1888. GONIATITES MICRONOTUS, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 312.
 1889. GLYPHIOCERAS MICRONOTUM, *E. Holzapfel*. Palæont. Abhandl., Dames und Kayser, vol. v, i, p. 28, pl. ii, fig. 1.
 1897. — — — *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 173, fig. 81 (suture-line), also fig. 74 (developmental).

Description.—"Shell discoidal, compressed, involute; greatest thickness at the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little more than one-half of the diameter of the shell. Whorls (? number); inclusion almost complete; umbilicus narrow, about one-twelfth of the diameter of the shell, infundibuliform, with subangular margin. Whorl semi-elliptical in section, a little higher than wide; indented to three-sevenths of its height by the preceding whorl; periphery narrowly convex; sides feebly convex, flattened; inner area narrow, sloping towards the umbilicus, somewhat flattened. Body-chamber occupying at least two-thirds of the last whorl. Chambers shallow, about nine in the last half-whorl preceding the body-chamber. Test thin, ornamented with very fine striæ, which are slightly waved on the sides and form a deep, broad, backwardly directed sinus on the periphery. Internal casts sometimes with four shallow constrictions having the same course as the ornaments, being deepest at the periphery and becoming very feeble near the umbilicus. Initial chamber ellipsoidal or spindle-shaped, transversely elongate. Shell attaining a diameter of about 33 mm." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Affinities.—Holzapfel (loc. cit.) compares the suture-line of the present species with that of *Glyphioceras* (*Beyrichoceras*) *truncatum*, Phil., but the resemblance is not very close. The whorls in the former are more compressed than in the latter species. The ornaments of the test in *G. micronotum* would be the best guide for distinguishing the species.

Remarks.—The single individual in the "Griffith Collection" bearing the name of *G. (B.) micronotum* is very small and badly preserved, and is partly covered by the rock in which it is embedded. I have therefore figured a larger and better specimen in the British Museum; this one is labelled "Kildare, Ireland."

Localities.—Clane, county of Kildare (exact locality in the county unknown); Ballinacourty (Dungarvan), county of Waterford (*vide* Griffith).

GLYPHIOCERAS (BEYRICHCERAS) DIADEMA ? *H. E. Beyrich*, sp. Plate XLVII, figs. 4, 5, 6 *a, b*; Plate XLIX, figs. 8 *a, b*.

1832. AMMONITES DIADEMA (*Goldfuss*), *A. H. Dumont*. Mém. const. géol. Liège, p. 356 [nom. nud.].
- ? 1835. GONIATITES STRIOLATUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 14—18.
1837. AMMONITES DIADEMA (*Goldfuss*), *H. E. Beyrich*. De Goniatitibus in montibus rhenanis occurrentibus, p. 15, pl. ii, figs. 8—10.
- LISTERI, *H. E. Beyrich*. Ibid., p. 14, pl. ii, figs. 6 *a, b*, 11.
- DIADEMA (*Goldfuss*), *E. Beyrich*. Beitr. zur Kenntn. Verstein. rhein. Uebergangsgeb., p. 41, pl. ii, figs. 8—10 (descriptions and figures as in 'De Goniatitibus').
- LISTERI, *E. Beyrich*. Ibid., p. 39, pl. ii, figs. 6 *a, b*, 11.
- 1842-44. — DIADEMA, *L. G. de Koninck*. Descr. Anim. Foss., p. 574, pl. i, figs. 1 *a—f*, 2 *a, b*.
1843. GONIATITES DIADEMA, *L. G. de Koninck*, in *J. J. d'Omalus d'Hallo*y, Précis élém. géol. p. 515.
- — BEYRICHIANUS, *L. G. de Koninck*. Ibid., p. 515.
- ? — — STRIOLATUS, *J. Morris*. Cat. Brit. Foss., p. 180.
- ? 1844. — — *F. McCoy*. Synops. Carb. Foss. Ireland, p. 16.
1845. DIADEMA, *E. de Verneuil*, in *Murchison*, de Verneuil, and de Keyserling, Géol. Russie d'Europe, vol. ii, p. 367, pl. xxvii, figs. 1 *a—d*.
- ? 1848. STRIOLATUS, *J. H. Cumming*. Isle of Man, p. 357.
- DIADEMA, *H. G. Bronn*. Gesch. der Natur, vol. iii, p. 541.
1850. AGANIDES DIADEMA, *A. d'Orbigny*. Prod. de Paléont. Stratigr., vol. i, p. 116.
- ? — — STRIOLATUS, *A. d'Orbigny*. Ibid., p. 115.
1851. GONIATITES DIADEMA, *G. Sandberger*. Jahrb. Nassau Verstein. Nat., pt. vii (ii and iii), p. 304, pl. iii, fig. 33.
1852. AMMONITES LISTERI (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 475.
1854. GONIATITES DIADEMA, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 303.
- ? — STRIOLATUS, *J. Morris*. Ibid., p. 304.
1855. AGANIDES DIADEMA, *F. McCoy*. Brit. Pal. Foss., p. 563.
- ? 1855-57. GONIATITES STRIOLATUS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
- ? 1863. DIADEMA, *F. Roemer*. Zeitschr. Deutsch. Geol. Gesell., vol. xxv, p. 578, pl. xv, figs. 1 *a—c*.
- LISTERI, *F. Roemer*. Ibid., vol. xv, p. 580, pl. xv, figs. 2 *a, b*.
1880. DIADEMA, *W. Branco*. Palæontographica, vol. xxvii, pl. iv, fig. 1.
1883. GLYPHIOCERAS DIADEMA, *A. Hyatt*. Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.

1884. "AMMONITES DIADEMA, L. v. Puch," *E. Beyrich*. Zeitschr. Deutsch. Geol. Gesell., vol. xxxvi, pp. 213—215.
1888. GONIATITES DIADEMA, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 311.
- ? — — STRIOLATUS, *R. Etheridge*. Ibid., p. 313.
1889. GASTRIOCERAS DIADEMA, *E. Holzappel*. Paläont. Abhandl., Dames und Kayser, vol. v, i, p. 26.
1890. GLYPHIOCERAS DIADEMA, *G. Steinmann und L. Döderlein*. Elemente der Paläontologie, pt. 2, p. 393.
1894. — — — *A. Hyatt*. Proceed. Amer. Philos. Soc., vol. xxxii, p. 620, pl. ii, fig. 27, "Phylogeny of an Acquired Characteristic."
1895. — — — *K. A. v. Zittel*. Grundzüge der Paläontologie, p. 399.
1897. — — — *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 202, figs. 98 a—c.
- — — *James Perrin Smith*. "Development of Glyphioceras and the Phylogeny of the Glyphioceratidae," Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 111.
1899. GONIATITES STRIOLATUS, *James Spencer*. Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, pt. 4, p. 391.
1901. GLYPHIOCERAS DIADEMA, *Wheelton Hind and J. A. Howe*. Quart. Journ. Geol. Soc., vol. lvii, p. 372, etc.
1903. — — — *Wheelton Hind*. Brit. Assoc. Adv. Sci., Belfast, 1902, p. 215, "Life-zones in the Carboniferous Rocks."

Description.—"Shell variable, discoidal, umbilicated, the young much more inflated than the adult; greatest thickness near the edge of the umbilicus, about two-fifths of the diameter of the shell; height of outer whorl about one-half of the diameter of the shell. Whorls (? number); inclusion nearly complete; umbilicus shallow, about one-fifth of the diameter of the shell in width, the edge with a slightly raised rim in the young shell, but wanting this in the adult. Whorl almost semilunate in section in the young, elongate-oval in the adult, higher than wide (in the young the reverse of this is the case); indented to nearly one-half of its height by the preceding whorl; periphery narrowly convex; sides inflated in the young, compressed in the adult; inner area flat, sloping towards the umbilicus, and thus forming an obtuse angle with the sides of the shell. Body-chamber occupying at least one whorl. Chambers very shallow, eighteen or nineteen to a whorl. Test ornamented with fine striae, most of which bifurcate in the umbilical region in the adult shell; they are sigmoidal upon the sides of the shell, and form a backwardly directed, linguiform sinus on the periphery; in very young shells the striae are

simple and their course is nearly straight. A number of shallow constrictions (from three to five per whorl) concurrent with the striæ are present, and are more conspicuous on casts. Initial chamber ellipsoidal or spindle-shaped, transversely elongate."

"This species is very variable: sometimes it has a relatively small umbilicus and a rather finely ornamented test, the young having much the same characters but being rather more inflated; sometimes it has an open umbilicus and a more or less coarsely striated test, the ornaments being much coarser in the young than in the adult. Since there are intermediate forms connecting the two extremes, and as they all have the same form of suture-line, we refer them to one species.

"Shell attaining a diameter of 66 mm." ('Cat. Foss. Ceph.,' loc. cit.)

Affinities.—This species is not unlike the young forms of *Glyphioceras* (*Beyrichoceras*) *truncatum*, but the periphery is rounded, and, when the suture-lines are compared, it is seen that the resemblance is only superficial and external. A feature which calls for notice in the suture-line of the present species is the considerable height and width of the peripheral lobe, for which it is difficult to find a parallel in any other species of *Glyphioceras*, the only one coming near to it being *G. Phillipsi*, Foord and Crick.¹ This species differs, however, from the present one in its more compressed form and narrower umbilicus. As compared with *G. (B.) excavatum*, J. Phillips, *G. (B.) diadema* has a smaller umbilicus and very distinct sigmoidal lines of growth, while the suture-line has a much more elevated median saddle.

Remarks.—I have referred some specimens rather doubtfully to this species. These are represented by figs. 4, 5, and 6 on Pl. XLVII, and fig. 8 on Pl. XLIX. The former consist of pyritised casts contained in a slaty rock, from which it is difficult to extract them whole. The suture-lines are beautifully preserved, and appear as delicate lines traced upon the smooth surface of the cast. The specimens are all small, the largest measuring only 27 mm. in diameter, the smallest about 12 mm. Shallow constrictions are present in all the specimens.

A specimen in the museum of the Royal College of Science for Ireland, from a locality "four miles east of Loughrea," seems also to have some claim to belong to the present species. The lines of growth have the distinctly sigmoid curvature in crossing the sides of the shell, characteristic of *G. (B.) diadema*. The periphery is somewhat depressed, and the umbilicus is small. The sutures are not seen. The specimen measures 48 mm. in diameter.

The specimen figured on Pl. XLIX (fig. 8) has now to be referred to. The most prominent feature in this is the distinctly sigmoidal character of the lines crossing the sides of the shell, and becoming more prominent where they bend sharply forward near the periphery. This is quite characteristic of the species to which

¹ 'Cat. Foss. Ceph. British Museum,' pt. 3, p. 172, fig. 80 (suture-line).

I have doubtfully referred this form. The rather large and open umbilicus is not quite in accordance with the more typical forms of *G. diadema*, though it has been pointed out that that species has sometimes a small, sometimes a comparatively large umbilicus.¹

It must be observed that if the interpretation of this fossil is the correct one, the horizon of the species would be extended below that in which it has hitherto been identified, viz. the Yoredale Series.

Some specimens (casts) from Redesdale, Yorkshire, kindly lent to me by Dr. Wheelton Hind (agreeing remarkably well with de Verneuil's excellent figures²), have been very useful to me for comparison with the Irish specimens. The evidence in favour of the affinities of the latter here suggested seems fairly well grounded, though the absence of the test in the pyritised casts, and of the suture-line in the other two specimens, introduce an element of doubt.

There is little likelihood that all the forms assigned to *Glyphioceras diadema* really belong to the species described by Beyrich under that name, but as it has attained the distinction of being a very variable species it is hard to determine what are its limitations.

Localities.—Kinsale, county of Cork. "Four miles east of Loughrea," county of Galway.

GROUP OF GLYPHIOCERAS (BEYRICHCERAS) RETICULATUM.

GLYPHIOCERAS (BEYRICHCERAS) RETICULATUM, *J. Phillips*, sp. Plate XLIX, figs. 2 *a, b*,
3 *a, b*.

1836. GONIATITES RETICULATUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 235,
pl. xix, figs. 26—32.
— — GIBSONI, *J. Phillips*. Ibid., p. 236, pl. xx, figs. 13—18.
1841. — JUGOSUS, *T. Brown*. Trans. Manchester Geol. Soc., vol. i,
p. 215, pl. vii, figs. 14, 15.
1843. — GIBSONI, JUGOSUS, RETICULATUS, *J. Morris*. Cat. Brit. Foss.,
pp. 179, 180.
1844. — GIBSONI, RETICULATUS, *F. McCoy*. Synops. Carb. Foss. Ireland,
pp. 13, 15.
1848. — RETICULATUS, *J. H. Cumming*. Isle of Man, p. 357.
— — GIBSONI, JUGOSUS, RETICULATUS, *H. G. Bronn*. Gesch. der
Natur, vol. iii, pp. 542, 544.
1850. AGANIDES DIADEMA (pars), *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i,
p. 116.

¹ 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1897, p. 204.

² 'Géologie de la Russie d'Europe,' loc. cit.

1852. AMMONITES RETICULATUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 471.
1854. GONIATITES GIBSONI, JUGOSUS, RETICULATUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., pp. 303, 304.
1855. AGANIDES RETICULATUS, *F. McCoy*. Brit. Pal. Foss., p. 566.
- ? 1855-57. GONIATITES GIBSONI, RETICULATUS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1860. — CRENISTRIA, *W. H. Baily*. Expl. Sheet 142 Geol. Surv. Ireland, pp. 11, 12, figs. 2 a—h, j, l, m (? i, k).
1862. — GIBSONI, RETICULATUS, *J. W. Salter*. Geology of the Country around Bolton-le-Moors (Mem. Geol. Surv.), pp. 34, 35.
1864. — — — — — Geology of the Country around Oldham (Mem. Geol. Surv.), p. 59.
1876. — — — — — *J. Armstrong, J. Young, and D. Robertson*. Cat. Western Scottish Fossils, p. 58.
1884. MUNSTEROCERAS RETICULATUM, *A. Hyatt*. Proc. Boston Soc. Nat. Hist., vol. xxii, p. 326.
1888. GONIATITES GIBSONI, JUGOSUS, RETICULATUS, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, pp. 311, 312.
- GASTRIOCERAS GIBSONI, *M. Tzvetzæev*. Mém. Com. géol. St. Pétersbourg, vol. v, No. 3, p. 1.
1893. GONIATITES JUGOSUS, *H. Bolton*. Cat. Types and Figured Specimens, Manchester Museum, p. 15.
1897. GLYPHIOCERAS RETICULATUM, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 193, fig. 94 (suture-line).
1898. GONIATITES CRENISTRIA, *A. McHenry and W. W. Watts*. Guide to the Collection of Rocks and Fossils belonging to the Geological Survey of Ireland, p. 124.
1899. RETICULATUS, *James Spencer*. Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, pt. 4, p. 391.
1901. GLYPHIOCERAS RETICULATUM, *Wheelton Hind and J. A. Howe*. Quart. Journ. Geol. Soc., vol. lvii, p. 349, etc.
1902. — — — — — *Wheelton Hind*. Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 296, "Life-zones in the British Carboniferous Rocks."
- [Not 1854. GONIATITES RETICULATUS, *F. A. Roemer*. Palæontographica, vol. iii, pl. xiii, fig. 31.]

Description.—"Shell discoidal, somewhat inflated, with four or five angulated constrictions on the outer whorl; greatest thickness at the edge of the umbilicus, nearly one-half of the diameter of the shell; height of outer whorl a little more

than one-half of the diameter of the shell. Whorls six or seven; inclusion almost complete; umbilicus about one-fourth of the diameter of the shell in width, with angular margin and sloping sides. Whorl obtusely sagittate in section, rather higher than wide; indented to a little more than one-half of its height by the preceding whorl; periphery subangular; sides feebly convex, with an obtuse spiral ridge near their centre; inner area rather narrow, well defined, flattened, sloping towards the umbilicus. Body-chamber occupying a complete whorl. Chambers rather shallow. . . . Test thin, delicately reticulate; the transverse striæ very finely crenulate, strongly arched forward near the periphery, and forming thereon a deep broad sinus; its inner surface with angulated thickenings, producing constrictions on the internal cast. Initial chamber small, transversely ovoid."

"Immature forms differ from the adult in being less inflated and in having a more convex periphery. The constrictions are scarcely visible on the test, but are well marked on the internal cast. By breaking back and by sectioning adult examples we have been able to satisfy ourselves that the young stages are what have been named *Gon. Gibsoni*; these not uncommonly have a slightly sulcated periphery (more conspicuous in an internal cast), and have been described as *Gon. jugosus*."

"Shell attaining a diameter of about 45 mm." ('Cat. Foss. Ceph. Brit. Mus.,' loc. cit.)

Affinities.—The relationship of the present species to *Glyphioceras* (*Beyrichoceras*) *excavatum* is referred to under the description of that species; it has also some affinities with *G. (B.) Davisi*, Foord and Crick,¹ but the latter has a more inflated form and an acutely angular periphery.

Remarks.—This species is represented in the "Griffith Collection" only by some crushed fragments in shale, but the characteristic ornamentation sufficed for its determination. The specimens are, however, not in a condition to serve for illustration.

Localities.—Mullaghtinny (Cloger), county of Tyrone; Doon, Mount Phelim, one mile south-west of Kiltendra, county of Clare; Paget Priory, five miles north of Maynooth—a local name,—county of Meath (the specimen from the last-named locality is labelled "*Goniatites Gibsoni*"); Rathcahill, near Abbeyfield, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) SUBRETICULATUM, sp. nov. Plate XLIX, figs. 6 *a*, *b*,
7 *a*—*d*.

Description.—Shell (young?) discoidal, compressed, umbilicated; greatest thickness at the edge of the umbilicus, about one-half of the diameter of the shell;

¹ 'Cat. Foss. Ceph. British Museum,' part iii, 1897, p. 198, figs. 95 *a*—*c*.

height of outer whorl in the same proportion. Number of whorls unknown; inclusion nearly complete. Umbilicus probably rather deep, almost exactly one-fourth of the diameter of the shell in width, with a subangular margin and steep inner area. Whorl semi-oval in section, height and width nearly equal; indented to about one-third of its height by the preceding whorl. Periphery narrowly convex, separated from the sides by an obscure ridge. Sides flattened. Extent of body-chamber unknown. Chambers shallow. Suture-line as in Pl. XLIX, fig. 7 *d*. Test covered by a multitude of delicate, regular, crenulated lines, which bifurcate near the umbilical margin. At intervals one or two of the lines are elevated slightly above the others, giving the appearance of slight ridges where this occurs. The lines are distinctly sigmoid in crossing the sides of the shell. Starting from the umbilical margin they curve slightly backwards at about the middle of the sides, then curve strongly forwards and again backwards upon the periphery, where they make a deep linguiform sinus. Faint spiral lines, a little stronger near the periphery, cover the whole of the test. Two broad and shallow constrictions crossing the sides and periphery in the same direction as the crenulated lines appear upon the cast. No trace of constrictions can be seen where the shell is present.

Dimensions.

				Specimen in the Dublin Mus. Sci. and Art (Geol. Surv. Coll.), No. 845 C.
Diameter of shell	.	.	.	23.0 mm.
" umbilicus	.	.	.	5.5 "
Height of outer whorl	.	.	.	12.0 "
" above preceding whorl	.	.	.	8.0 "
Thickness at umbilical margin	.	.	.	11.0 "

Affinities.—From the nature of the ornaments this species would appear to belong to the *reticulatum* group, but it is a much more compressed shell and the reticulations much finer than in *Glyphioceras* (*Beyrichoceras*) *reticulatum* itself; the umbilicus is also much smaller in the present species than in the latter. The suture-line is characterised by the obtuse form of the lateral lobe, at least in the young shell, the suture of which is figured (Pl. XLIX, fig. 7 *d*). When the septa are not seen the ornamentation of the shell will suffice for the recognition of the species. Another specimen from the same locality, and I believe the same band of rock, is doubtfully referred to this species. It is a cast of the greater part of the body-chamber, with the septa, which are somewhat eroded, occupying about one-third of the whorl. The ornamentation is obscurely seen upon the cast; it resembles that of the present species. A very fine keel extends along the median line of the periphery (Pl. XLIX, fig. 6 *b*).

Locality.—Foynes Island, county of Limerick.

GLYPHIOCERAS (BEYRICHCERAS) BILINGUE, *J. W. Salter*, sp. Plate XLIX, fig. 1.

- | | | | | |
|-------|------------------------|-------------------------------------|--|---|
| 1864. | — | — | <i>GONIATITES BILINGUIS, J. W. Salter.</i> | Mem. Geol. Surv., Geology of the Country around Oldham, p. 60, figs. 14 a—c. |
| 1885. | — | — | <i>R. Etheridge.</i> | Mem. Geol. Surv., Geology of the Country around Rhyl, Abergele, and Colwyn, p. 17. |
| 1888. | — | — | — | Brit. Foss., vol. i, Palæozoic, p. 311. |
| 1896. | — | — | <i>H. Bolton.</i> | Trans. Manchester Micro. Soc. for 1895, pp. 130, 134. |
| 1897. | GLYPHIOCERAS BILINGUE, | <i>A. H. Foord and G. C. Crick.</i> | | Cat. Foss. Ceph. British Museum, pt. 3, p. 192, fig. 93 (suture-line). |
| 1901. | — | — | <i>Wheelton Hind and J. A. Howe.</i> | Quart. Journ. Geol. Soc., vol. lvii, p. 356, etc. |
| 1902. | — | — | <i>Wheelton Hind.</i> | Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 296, "Life-zones in the British Carboniferous Rocks." |
| 1903. | — | — | — | Ibid., Belfast, 1902, p. 218, etc., "Life-zones in the British Carboniferous Rocks." |

Description.—The following is the description of this species contained in the 'Catalogue of Fossil Cephalopoda, British Museum,' pt. 3, 1897, and is here transcribed because it is based upon much more complete material than I have at my disposal for describing the species:—"Shell compressed, involute; greatest thickness at the edge of the umbilicus rather more than four-ninths of the diameter of the shell; height of outer whorl nearly one-half of the diameter of the shell. Whorls (?number); inclusion almost complete; umbilicus infundibuliform, with angular margin and sloping sides, nearly one-fourth of the diameter of the shell in width. Whorl bluntly sagittate in section, a little higher than wide; indented to about two-fifths of its height by the preceding whorl; periphery convex, a little flattened; sides feebly convex, with a double spiral furrow near the periphery, their portion internal to the furrow flattened; inner area distinctly marked off, narrow, sloping towards the umbilicus. Body-chamber occupying a complete whorl; aperture with a projecting tongue-like lobe on either side near the periphery, and a deep broad hyponomic sinus. Chambers rather shallow. . . . Test thin, its surface delicately reticulate; transverse striæ very finely crenulate, strongly arched forward at the double concentric groove and forming a deep broad sinus on the periphery; longitudinal striæ very feeble."

"All the examples of this species in the Jermyn Street Museum are either very

much crushed or are merely impressions on the surface of pieces of shale occurring in the Millstone Grit. No specimen can there be found so well preserved as represented in Salter's figure, and we have not seen the suture-line in any of these examples. There are two forms: one with a rather open umbilicus exposing the edges of the inner whorls, on which, as well as on the inner edge of the outer whorl, the fine ornaments of the test are accompanied by small folds; the other with a much finer ornamentation, and a smaller and infundibuliform umbilicus. The specimens in the National Collection agree with the latter. Shell attaining a diameter of 56 mm." The specimens in the British Museum are from Halifax, Yorkshire.

Dimensions.

			Specimen from Caher Lane in the Dublin Mus. Sci. and Art (Geol. Surv. Coll., No. 2208 C).
Diameter of shell (approximately)	.	.	28 mm.
„ umbilicus .	.	.	6 „
Height of outer whorl .	.	.	14 „

Affinities.—On the whole this species seems to be most nearly allied to *Glyphioceras* (*Beyrichoceras*) *reticulatum*, but the ornamentation in the latter is much coarser than it is in *G. bilingue*, though, as remarked in the description of *G. (B.) Davisi*, it is of a similar character. The umbilicus is smaller than that of the specimens described in the 'Catalogue of Fossil Cephalopoda, British Museum,' p. 193, but this may be only an individual variation.

Salter's figure (loc. cit.) has all the appearance of being a "restoration," and there is apparently no individual specimen in the Jermyn Street Museum which can be recognised as the original of it. The description given by Salter has, however, sufficed to distinguish the species, the "exaggerated processes on the edge of the mouth" causing the "double concentric furrow near the periphery," making it easily recognisable. This feature in it is seen in a milder form in the larger of Phillips's figures of *G. reticulatum* ('Geol. Yorks,' ii, pl. xix, fig. 27). It is to be observed that there are no constrictions on the shell in the present species.

Localities.—Caher Lane (No. 2208 C), and Rathcahill (No. 3429 C), near Abbeyfield, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) DAVISI? *A. H. Foord and G. C. Crick.* Plate XLIX, fig. 4.

1897. GLYPHIOCERAS DAVISI, *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 198, figs. 95 a—c.

Description.—Shell somewhat inflated, umbilicated, greatest thickness at the edge of the umbilicus; height of outer whorl about one-half of the diameter of the shell.

Whorls probably five or six; inclusion almost complete; umbilicus about one-third of the diameter of the shell in width, the sides steep, the margin subangular, exposing the edges of the inner whorls; inner area well defined, rather narrow, almost at right angles to the plane of symmetry. Test thin, the ornamentation consisting of regular, distinctly crenulated transverse striæ, which bifurcate shortly after leaving the margin of the umbilicus; these take a nearly straight course for a short distance, then bend backwards, then more strongly forwards. (The peripheral area is not preserved.) Faint spiral lines are seen on the sides of the shell, which nearer the periphery become as prominent as the transverse striæ, and produce a reticulate structure. At about two-thirds of the distance across the lateral area there is a distinct rounded spiral ridge, which on the side nearest to the periphery merges in a depression in which the transverse striæ make their strongest forward curvature. No constrictions are to be seen. The suture-line is unknown.

Affinities.—The evidence in favour of this species being identical with *Glyphioceras Davisi*, Foord and Crick, is not quite conclusive, I have therefore put a note of interrogation after the name. The doubt arises from the absence of the suture-line and other imperfections in the only specimen that has come to my notice. The general character of the ornamentation, crenulated and bifurcating striæ, is well brought out in fig. 7 c, Pl. XLIX—an allied species.

Remarks.—This species forms one of a group which includes *Glyphioceras* (*Beyrichoceras*) *reticulatum*, *G. (B.) subreticulatum*, and *G. (B.) bilingue*. In all these the ornaments of the shell are strikingly similar in their character,—that is, they consist of crenulated, transverse, often bifurcating striæ, with more or less strongly developed spiral striæ crossing them, the latter always strongest in the peripheral region. This species was found at Rathcahill associated in the same beds with *G. (B.) reticulatum* and *G. (B.) pulchellum*.

Locality.—Rathcahill, near Abbeyfield (No. 3435 C), and Foynes Island (No. 813 C, pars), county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) CORDATUM, *G. C. Crick*. Plate XLVII, figs. 2 a—c.

1899. GLYPHIOCERAS CORDATUM, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 445, fig. 10.

Description.—Shell discoidal, rather inflated, lenticular, narrowly and deeply umbilicated; greatest thickness at a short distance from the umbilical margin, a little more than one-half of the diameter of the shell; height of outer whorl a little less than one-half of that diameter. Whorls probably not less than four, but the exact number cannot be stated owing to the outer one being imperfect. Inclusion

about five-sixths; umbilicus very deep and step-shaped, with subangular margins and steep sides, the depth from the edge of the outer whorl about 28 mm.; about one-fourth of the diameter of the shell in width. Whorl distinctly cordate in cross-section in the region of the aperture; a little wider than high; indented to nearly one-half of its height by the preceding whorl. Periphery narrowly convex, its boundaries imperfectly defined upon the cast by an obtuse and obscure ridge on each side of it; these ridges are not seen where the shell is present. The periphery becomes acute towards the aperture, when all trace of the ridges disappears. The sides are slightly convex, with a faint obtuse ridge, also upon the cast only, at about three-fifths of the width of the side from the edge of the umbilicus, becoming obsolete, as is the case with the peripheral ridges, on the anterior part of the body-chamber. Umbilical zone well defined, rather narrow, nearly perpendicular to the plane of symmetry of the shell. Body-chamber occupying at least the whole of the last whorl, probably exceeding this limit; aperture not preserved, but the lines of growth upon the test indicate that the peristome was furnished with a prominent lateral crest and a deep and narrow hyponomic sinus. Chambers rather shallow. Suture-line as in Pl. XLVII, fig. 2 *c*. Test nearly smooth, with lines of growth which have a nearly radial direction on the inner portion of the lateral area, then bend forwards and finally backwards to form the deep and narrow hyponomic sinus upon the periphery. The cast, especially in the anterior region of the body-chamber, shows distinct traces of the faint lines of growth that ornament the test.

Dimensions.

		Type specimen in Museum of Science and Art, Dublin.
Diameter of shell . . . . .	.	116.5 mm.
„ umbilicus (edge to edge) . . . . .	.	28.5 „
„ „ (suture to suture) . . . . .	.	26.0 „
Height of outer whorl (about) . . . . .	.	51.5 „
„ above preceding whorl (about) . . . . .	.	27.5 „
Thickness at umbilical margin . . . . .	.	56.0 „

The measurements which relate to the diameter of the shell must be taken as approximate, as the shell has been rendered somewhat elliptical by rock pressure. The longer of the two diameters has been given in the dimensions of the umbilicus, the shorter in those of the shell, as a large piece of the outer whorl has been broken off, making measurements of the longer diameter very difficult to effect.

Affinities.—Mr. Crick (loc. cit.) observes that “this species is evidently closely related to such forms as *Glyphioceras reticulatum*, J. Phillips, sp.,¹ and *Glyphioceras Davisi*, Foord and Crick.”²

¹ ‘Geol. York,’ pt. ii, 1836, p. 235, pl. xix, figs. 26–32. Also ‘Cat. Foss. Ceph. British Museum,’ pt. iii, 1897, p. 193.

² ‘Cat. Foss. Ceph. British Museum,’ pt. iii, 1897, p. 198, fig. 95.

This relationship shows itself in the case of *G. (B.) Davisi* in the acute periphery, and in both species in the presence of the lateral crest indicated in the ornaments of the test. The deep and angular-margined umbilicus in *G. (B.) reticulatum* and *G. (B.) Davisi* is also paralleled in *G. (B.) cordatum*.

Remarks.—The only individuals of this species known to me, two in number, were obtained in the great quarries of Little Island which overlook one of the lower reaches of the river Lee, about four miles below the city of Cork, locally known as Lough Mahon. Both specimens are distorted, the one whose dimensions are given above much less so than the other, which is stretched out into a long ellipse, whose greater diameter would be at least double that of the normal diameter of the shell. Such is the condition of many of the fossils in the Carboniferous rocks of the south of Ireland, these rocks having undergone severe pressure, which has thrown them into numerous folds and dislocations, involving the distortion of the fossils contained in them.

Locality.—Little Island, near Cork.

GLYPHIOCERAS (BEYRICHCERAS) PULCHELLUM, sp. nov. Plate XLIX, fig. 5.

Description.—Shell rather small, somewhat inflated, umbilicated; height of outer whorl rather more than half the diameter of the shell. Whorls apparently few in number. Inclusion nearly complete. Umbilicus one-fifth of the diameter of the shell, deep, infundibuliform, with steep sides and subangular margin. Whorl bluntly sagittate in section, apparently a little wider than high, but the exact proportions cannot be determined, as only one-half of the shell is free from the rock; indented to about three-eighths of its height by the preceding whorl. Periphery narrowly rounded. Lateral area regularly convex, appearing in profile as a very broad and spreading arch; becoming a little depressed in the upper half near the aperture. Test ornamented with very fine but perfectly distinct thread-like lines, apparently with crenulations; proceeding from the umbilicus they pursue at first a nearly straight course, but soon make a slight curve backwards, then curving boldly forward they pass over the periphery in a strong backwardly directed curve, thus forming a deep sinus in that region. Towards the aperture the anteriorly directed curve becomes narrower and more tongue-like in form, and the lines have here a tendency to form little bundles, which cause them to stand out more prominently. Two narrow and shallow constrictions, which conform in direction to the lines of the ornamentation, are developed upon the test. Very faint spiral lines are seen covering the test all over. (It must not be supposed that these lines produce the effect of reticulation: they can only be seen with a lens; the transverse lines are easily discernible without such aid.) Body-chamber and septa unknown.

Dimensions.

Specimen from Rathcahill, in Science
and Art Mus., Dublin (Geol. Surv.),
No. 3450 C.

Diameter of shell	.	.	.	.	30 mm.
„ umbilicus	.	.	.	.	6 „
Height of outer whorl	.	.	.	.	15 „

Affinities.—This species seems to have affinities with the *reticulatum* group, and in particular with *G. (B.) reticulatum* itself. It differs from this species in its much smaller umbilicus, and in the character of its ornaments, the delicacy of which is remarkable; the transverse striæ are in fact much finer than those of *G. (B.) reticulatum*, and the spiral ones so conspicuous in the latter are only feebly developed in the present species, so as to be scarcely perceptible without the assistance of a lens. The contrast between the two species as respects their ornamentation, etc., is well represented in figs. 2 *a* and 5 of Pl. XLIX.

Locality.—Rathcahill, near Abbeyfield, county of Limerick.

GLYPHIOCERAS (BEYRICHCERAS) SPIRALE, *J. Phillips*, sp. Plate XLIX, fig. 9.

1841. GONIATITES SPIRALIS, *J. Phillips*. Pal. Foss. Cornwall, Devon, and West Somerset, p. 121, pl. 1, fig. 233.
1843. — GRANOSUS, *J. E. Portlock*. Geology of Londonderry, p. 407, pl. xxix A, fig. 9.
- — STRIATUS, *F. A. Roemer*. Verstein. Harzgeb., p. 34, pl. ix, figs. 11 *a*, *b*.
- — SPIRALIS, *J. Morris*. Cat. Brit. Foss., p. 180.
- — GRANOSUS, *J. Morris*. Ibid., p. 179.
1844. — SPIRALIS, *F. McCoy*. Synops. Carb. Foss. Ireland, p. 16.
1848. — — *H. B. Brown*. Geschich. d. Natur, vol. iii, p. 544.
1852. AMMONITES SPIRALIS, *C. G. Giebel*. Fauna der Vorwelt, vol. iii, pt. 1, p. 454.
1854. GONIATITES SPIRALIS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
- — GRANOSUS, *J. Morris*. Ibid., p. 303.
- 1855–7. — SPIRALIS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
- — GRANOSUS, *J. Kelly*. Ibid., vol. vii, p. 7.
1860. — SPIRALIS, *W. H. Baily*. Geol. Surv. Ireland, explan. of sheet 101 of the Maps, p. 13.
- 1862–4. — — *F. A. Roemer*. Palæontogr., vol. ix, p. 11, pl. iv, figs. 2 *a*—*c*.
1864. — — *J. W. Salter*. Geology of the Country around Oldham (Mem. Geol. Surv.), p. 59.
- ‡ 1878. — BAYLEI, *A. Leymerie*. Descrip. géol. et paléont. Pyrénées, p. 747, pl. c, fig. 4.
1888. SPIRALIS, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 313.

1897. GLYPHIOCERAS SPIRALE, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 210, fig. 101 (suture-line).
1901. — — *Wheelton Hind and J. A. Howe*. Quart. Journ. Geol. Soc., vol. lvii, p. 356, etc.
1902. — — *Wheelton Hind*. Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 289, etc., "Life-zones in the British Carboniferous Rocks."
1903. — — *Ibid.*, Belfast, 1902, p. 217, "Life-zones in the British Carboniferous Rocks."

Description.—Shell discoidal; whorls broad and apparently almost completely overlapping each other, thus leaving a very small umbilicus. Test ornamented with numerous fine, regular, spiral lines, which, so far as can be ascertained, are of a delicate thread-like character, varying according to the size of the specimen from .5 mm. to 1 mm. apart. These are crossed by a multitude of extremely delicate lines which in cutting the former produce in them a granular appearance, but so fine as to be scarcely visible to the naked eye.

Dimensions.

	Large specimen from Summer Hill, County of Meath, in Dublin Mus. Sci. and Art.	Specimen figured, Pl. XLIX, fig. 9.
Diameter of shell . . .	61 mm.	33.0 mm.
„ umbilicus . . .	—	3.5 „
Height of outer whorl . . .	31 „	15.0 „

These dimensions must be taken as only approximately correct, as the specimens are crushed perfectly flat.

The true form of this species has not been preserved in the fissile shales in which it occurs in this country, nor yet in England, as we learn from Phillips,¹ and recently from Wheelton Hind; but F. A. Roemer² figures an uncrushed specimen which indicates a shell of a somewhat compressed form, having the following measurements (derived from the figure):—diameter of shell 24 mm., height of outer whorl 12 mm., diameter of umbilicus 5 mm. Thickness of shell at umbilical margin 10 mm.

Roemer states that the number of spiral lines upon the last whorl is about fifty, and that the spaces between them are covered with much finer transverse lines.

Affinities.—Fragments of *Glyphioceras* (*Beyrichoceras*) *striatum* with the test well preserved have been mistaken for the present species; it would seem, therefore, that in respect to ornamentation there is some resemblance between the two species;

¹ Pal. Foss. Cornwall, Devon, and West Somerset, 1841, p. 121.

² Palaeontographica, 1862-4, vol. ix, pl. iv, figs. 2 a-c.

but it is little more than superficial. In *G. (B.) striatum* the shell is more inflated than in *G. (B.) spirale*, and the spiral lines in the latter are wider apart than they are in the former. There is considerable difference also in the form of the suture-line in the two species. But although distinguishable even in fragments there can hardly be any question as to their close relationship. Spiral ornamentation seems to be as rare among the Goniatites as the corresponding longitudinal ornamentation is among the straight-shelled Nautiloidea (Orthoceratites), or spiral ornaments in the coiled ones excepting in the younger stages of growth.

The "*Goniatites*" *granosus* of Portlock appears to represent only a particular state of preservation of *Glyphioceras spirale* in which the transverse lines are more conspicuous than they are in the casts of the shell usually met with. It is therefore included among the synonymy of the latter as in the 'Catalogue of Fossil Cephalopoda, British Museum,' part iii.

Remarks.—The slaty character of the deposits in which this species occurs has been fatal to its good preservation, and it appears only in the shape of casts crushed perfectly flat between the thin papery layers of the rock. Fragments of the test with its fine thread-like lines are sometimes seen scattered near the crushed shells, but it is usually met with in the condition of casts consisting of a series of regular, parallel incised lines crossed by curved transverse lines scarcely visible to the naked eye. The figure of this species on Pl. XLIX (fig. 9) shows very well the condition in which the species usually occurs.

The largest complete specimen measures 55 mm. in diameter. This is from Summer Hill Quarry in the county of Meath. A fragment (cast) measures 52 mm. from the centre of the umbilical cavity to a point near but not at the periphery; this represents a specimen which may have measured as much as 80 mm. in diameter. It comes from the same county as the other, from near Trim.

Localities.—Loughshinny, county of Dublin (No. N. 4299; V. 4301); Summer Hill and near Trim (No. 37 K), county of Meath; Killorglin, county of Kerry (Dingle Bay) (No. 3804 C).

Sub-genus MUNSTEROCERAS,¹ Hyatt, 1883.

GLYPHIOCERAS (MUNSTEROCERAS) CRASSUM, sp. nov. Plate XLII, figs. 10 *a*—*c*.

Description.—Shell of medium size, discoid, thick, somewhat compressed, the greatest thickness at the umbilical margin, rather more than two-fifths of the diameter of the shell; height of the outer whorl about three-fifths of the diameter

¹ For definition of this sub-genus see Appendix, p. 219.

of the shell. Inclusion of the whorls nearly complete; umbilicus small. Whorl semi-elliptical in cross-section, somewhat higher than wide, indented to about one-third of its height by the preceding whorl. Periphery rather broadly rounded, but with some tendency to flattening. Umbilical zone indistinct, merging with a slight degree of convexity in the sides of the shell. Extent of body-chamber unknown. Aperture unknown. Chambers of moderate depth, peripheral lobe of the suture-line very deep, with subparallel sides (Pl. XLII, fig. 10 c). Test apparently marked only with lines of growth, but its bad preservation precludes any detailed description of it.

Dimensions.

		Specimen in the Museum of Science and Art, Dublin (Geological Survey Collection, No. 547).
Longer diameter of shell (approximately)	.	75 mm.
" " umbilicus (about)	.	12 "
Height of outer whorl (about)	.	45 "
Thickness at umbilical margin (about)	.	35 "

These measurements are only rough approximations, as the shell is much distorted.

Affinities.—In the form of the suture-line this species closely resembles *Glyphioceras parallelum*, J. Hall, sp.,¹ especially in the length of the peripheral lobe and its nearly parallel sides. Hall's species was selected by Hyatt as the type of *Muensteroceras*.

Remarks.—Only one individual assignable to the present species has come under my notice. The thick form of the shell led me at first to regard it as closely allied to *G. (B.) obtusum*, but the suture-line when developed contradicted this view, and pointed to affinities with the group of species of which *G. (M.) parallelum*, J. Hall, sp., is the typical form.

Locality.—Ballinacarriga, county of Limerick.

GLYPHIOCERAS (MUENSTEROCERAS) ELLIPSOIDALE, *G. C. Crick*. Plate XLIII, figs. 1 a—c.

1899. GLYPHIOCERAS ELLIPSOIDALE, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7,
vol. iii, p. 499, fig. 14.

Description.—Shell subglobose, somewhat compressed at the sides, with rather broadly rounded periphery; unbilicated; greatest thickness at the umbilical margin, about four-sevenths of the diameter of the shell; height of outer whorl nearly three-

¹ Thirteenth Rep. New York State Cabinet Nat. Hist., 1860, p. 101, figs. 13, 14.

sevenths of the same. Number of whorls not known; inclusion about two-thirds. Umbilicus deep, with steep, nearly vertical sides and subangular margin, exposing the edges of the inner whorls, about two-sevenths of the diameter of the shell in width. Whorl very distinctly semi-elliptical in cross-section, height about three-fourths of the width; indented to nearly one-third of its height by the preceding whorl. Sides slightly convex, somewhat flattened near the umbilicus; umbilical zone narrow, slightly concave, nearly perpendicular to the plane of symmetry of the shell. Body-chamber occupying the whole of the last whorl; peristome with a widely curved lateral crest and broad and deep hyponomic sinus. Test smooth, with faint lines of growth near the aperture.

Dimensions.

		Type specimen from Kildare, in the Museum of Science and Art, Dublin.
Diameter of shell	.	83.0 mm.
„ umbilicus (edge to edge)	.	23.5 „
„ „ (suture to suture)	.	20.0 „
Height of outer whorl	.	36.0 „
„ above preceding whorl	.	25.0 „
Thickness at umbilical margin	.	47.0 „

Affinities.—The only species which resembles the present one in any marked degree is that which I have called *G. (M.) obesum*, which, being figured upon the same plate, can be readily compared. The form of the shell in each is considerably inflated, and in both the peripheral lobe of the suture-line has the subparallel sides characteristic of *Muensteroceras*. The test in both is smooth. In cross-section, however, the whorl in *G. (M.) ellipsoideale* is broadly arched above; in *G. obesum* it is narrower as well as being distinctly flattened—at least in the region of the body-chamber.

There is not very much difference between them in their umbilical characters. Allowing for the distortion in the specimen representing *G. (M.) obesum*, the umbilicus in this species is relatively smaller than that of *G. (M.) ellipsoideale*. Its more inflated and smooth shell and larger umbilicus suffice to distinguish the present species from *G. striatum*, J. Sow.

Remarks.—Mr. Crick¹ refers a specimen in the British Museum (No. C. 294) to the present species, but with some doubt; it is from the Carboniferous Limestone of Rathkeale.

Localities.—Kildare (exact locality in the county unknown); Little Island, near Cork; (?) Rathkeale, county of Limerick.

¹ Loc. cit., p. 450.

GLYPHIOCERAS (MUNSTEROCERAS) OBESUM, sp. nov. Plate XLIII, figs. 3 a—c.

Description.—Shell subglobose, rendered elliptical by pressure, the longer (antero-posterior) diameter measuring 112 mm., the shorter 100 mm.; greatest thickness at the umbilical margin, about one-half of the shorter diameter of the shell; height of outer whorl rather less than one-half of that diameter; inclusion almost complete. Outer whorl indented to about two-fifths of its height by the preceding whorl. Umbilicus proportionally small, about one-fifth of the smaller diameter of the shell, with subangular margin. Periphery at first very broadly rounded, but becoming subtruncate in the adult shell as the aperture is approached. Inner area narrow, slightly concave.

Body-chamber occupying at least an entire volution. Chambers shallow. Suture-line as in Pl. XLIII, fig. 3 c.

Test quite smooth, with only faint lines of growth, which may be seen here and there proceeding from the umbilicus. No distinct indications of constrictions can be seen, but the surface of the cast is badly preserved and eroded in places, and they may thus have been obliterated.

Dimensions.

Large specimen in the Collection of Mr. Joseph Wright, F.G.S.,
Belfast.

Diameter of shell (long)	. 112 mm.	. (short) 100 mm.
„ umbilicus (long)	. 21 „	. „ 18 „
Height of outer whorl .	. 48 „	
„ above preceding whorl .	. 32 „	
Thickness at umbilical margin .	. 53 „	

Affinities.—*Glyphioceras* (*Munsteroceras*) *ellipsoidale* has been compared with the present species under the description of the former.

Remarks.—The large individual representing the present species was obtained in the quarries of Little Island, and forms part of Mr. Joseph Wright's small but interesting collection from the neighbourhood of Cork.

Locality.—Little Island, near Cork.

GENUS GASTRIOCERAS, *Hyatt*, 1883 (emend. Karpinsky, 1890).

GASTRIOCERAS CIRCUMNODOSUM, sp. nov. Plate XLIX, figs. 10, 11.

Description.—Shell rather small, inflated, umbilicated; greatest thickness at the margin of the aperture; height of outer whorl about one-half of the diameter of the

shell. Whorls rather numerous, their number not precisely ascertainable; probably six or seven. Inclusion nearly complete. Umbilicus rather more than one-third of the diameter of the shell in width, with steep sides, the edges subangular and tuberculated, only the edge of the inner whorls exposed. Whorl semilunate in section, considerably wider than high, but the exact proportions cannot be given; indented to nearly one-third of its height by the preceding whorl. Periphery very broadly arched, merging in the lateral area. Umbilical walls steep, with subangular margin, bearing a single row of tubercles, which give rise to fine lines crossing the periphery, the nature of which cannot be very distinctly made out owing to the weathering of the fossil, but they appear to be fairly regular, raised lines, probably varying in prominence, crossing the periphery, with a very slight curvature, resembling the lines ornamenting the test in *Gastrioceras Listeri*, a well-known and closely related species. The tubercles are somewhat lengthened in a direction at right angles to the spiral of the shell, or, in other words, they radiate towards the centre of the umbilical cavity.

Body-chamber and septa unknown.

Dimensions.

Plaster cast of the largest of the original moulds. Fiorda (Kilkenny). Dublin Mus. Sci. and Art (Geol. Surv. Coll.).

Diameter of shell	.	.	.	31 mm.
„ umbilicus	.	.	.	11 „
Height of outer whorl	.	.	.	15 „
„ above preceding whorl (about)	.	.	.	10 „
Thickness at umbilical margin (about)	.	.	.	20 „

Affinities.—There are several species with which the present one may be compared. The most nearly related are *Gastrioceras Listeri* [W. Martin], J. de C. Sowerby, sp.;¹ *G. carbonarium*, von Buch, sp.; and *G. coronatum*, Foord and Crick. From the first of these *G. circumnodosum* is readily distinguished by its more contracted umbilicus and proportionately narrower periphery; it is certainly very closely allied to this species. From *G. carbonarium* the present species differs in its narrower and deeper umbilicus and its much more inflated form. *G. coronatum* is an allied form, but it has in all stages of growth more depressed whorls, a broader and more flattened periphery, and a wider umbilicus than *G. circumnodosum*. *G. Jossse*, de Vern., though resembling the present species in its encircling tubercles, has

¹ The numerous references to *G. Listeri* in the literature of Irish palæontology are erroneous. Several specimens in the Griffith Collection (Dublin Mus. Sci. and Art) also are labelled "*Goniatites Listeri*;" they are badly preserved specimens of *Pericyclis fasciculatus*, McCoy. The labels referred to are probably the original ones, dating from McCoy's 'Synopsis' (1844); the ink on them is much faded.

narrower and more numerous whorls and conspicuous spiral striæ, the latter being entirely absent in *G. circumnodosum*.

None of the species here compared with *G. circumnodosum* have been found up to the present time in Ireland.

In his important paper on the "Marine Fossils from the Coal Measures of Arkansas,"¹ J. Perrin Smith figures a specimen of *Gastrioceras* to which he does not assign any name, but which he describes as closely resembling *G. Marianum*, de Verneuil, in its young stage; while it is distinguished from *G. Marianum* in its adult stage by its narrower and more highly arched whorls. It appears to me that this species is intermediate in character, when mature, between *G. Listeri* and *G. Marianum*, and thus suggests affinities with *G. circumnodosum*, especially in the character of its ornaments, which consist of strong tubercles on the sides of the whorl; "which on the young stages are like those of *G. Marianum*, but on the adult form ribs reaching halfway from the umbilical shoulders to the ventral [peripheral] portion of the shell."

Mr. Perrin Smith describes *G. Marianum* in the same paper, giving figures of it in several stages of growth, up to a diameter of 54 mm. He recognises also in the same beds other "European Coal Measure forms not before known in America," viz. *Conoccardium aliforme*, J. Sowerby, and *Pronorites cyclobolus*, J. Phillips.

Remarks.—In the absence of the suture-line the generic position of the present species has been determined in conformity with its close resemblance to well-known species of *Gastrioceras*, especially to *G. Listeri*, its affinities with which have just been pointed out.

The specimens upon which the present description is based are a series of empty moulds crowded together upon the surface of a fragment of carbonaceous shale. The weathering to which the rock has been subjected, though considerable, has not been so severe as to obliterate the coarser ornaments of the shells which originally occupied the moulds. Of these ornaments very distinct remains are imprinted upon the concave surfaces of nearly all the moulds. By filling the latter with plaster of Paris, and thus producing a cast of the surface of the slab, the form of the original shell was reproduced, the figures 10 and 11 on Pl. XLIX representing two of the best preserved surfaces. The shells vary in size from 2 mm. (some probably even smaller) to 31 mm., the diameter of the larger of the two specimens figured.

For the cast, which was made in the Dublin Museum of Science and Art, I am indebted to the kindness of Mr. G. H. Carpenter of that museum. I was much assisted further in the determination of the present species by Dr. Arthur Smith Woodward, F.R.S., who very kindly had casts made for me in the British Museum

¹ 'Proc. American Phil. Soc., Philadelphia,' vol. xxxv, Nov., 1896, No. 152, p. 262, pl. xx, fig. 1.

of *Gastrioceras Listeri*, *G. carbonarium*, and *G. coronatum*. These were all very serviceable for comparison with the Firoda specimens. I am much indebted also to Dr. Wheelton Hind, who sent me, from his large collection of British Carboniferous Fossils, specimens of *G. Listeri* and *G. carbonarium* in different stages of growth. Thus I had ample material for the study of the present species in its relationship with those above named.

Before concluding the description of this species it may not be out of place to refer briefly to the history of *Gastrioceras Listeri*. The chief interest of this centres in the question, which I had the opportunity lately of discussing with Dr. Hind, as to whether the species figured by Martin (1809) under the name "Ammonites Listeri" is the same species as the one afterwards figured by J. de C. Sowerby (1825) under the same name. The specimen figured by Martin is lost, therefore only the description and figure are available as evidence; the latter is decidedly unsatisfactory, and would only represent very roughly the characters of the ornamentation of the shell now known as *Gastrioceras Listeri*.

Another difficulty is that Martin always describes his species as occurring "in limestone tracts," and associates it with the species (of many of which he was himself the author) commonly occurring in, and characteristic of, the Mountain Limestone. It is well known that *Gastrioceras Listeri*, as universally recognised, belongs to formations of higher horizons than the latter, extending upwards to the Coal Measures.

Therefore, if Martin's name *Listeri* is still to be employed, it must be with the understanding that he was in error as to the horizon of his species. Though it is impossible to ascertain the exact locality whence Martin obtained his figured specimen and others—for he recognised the species as common,—the locality he vaguely referred to as "near Eyem [or Eyam] and Middleton" must have included rocks other than the Mountain Limestone, because, according to all experience, *G. Listeri* is not found at so low an horizon. It seems in the highest degree probable that the conjecture as to the stratigraphical origin of Martin's figured specimen quoted in the foot-note below is correct.¹

In concluding these observations I may draw attention to a point which, however trifling it may seem, is worthy of note, namely, that in the hand-colouring of Martin's figure gold has been used to represent iron pyrites, a mineral of common

¹ Dr. Wheelton Hind, with characteristic enthusiasm, made a journey to Eyam and Middleton in April of this year (1903) to find out what rocks occur at those places, and he wrote to me giving me a sketch of the section there, showing the Mountain Limestone and the Pendleside Series in connection with it. "The Pendleside Series," he said, "contains thin black limestones in which *G. Listeri* occurs at other localities, so that it is probable the specimens [Martin's] were obtained from these beds, which were extensively worked in past years for lead veins which traversed them. These beds are above the Yoredale Series of Wenleysdale, in which *G. Listeri* has never yet been found."

occurrence in the Coal Measures, and present in all the specimens of *G. Listeri* I have met with from that horizon.

It is interesting to learn that Mr. James Perrin Smith, who has already done much good work in the embryology of the ammonoids, has made known the occurrence for the first time in America of *Gastrioceras Listeri*, associated with the nearly related species *G. carbonarium* and other Goniatites (*Glyphioceras* [*Sphenoceras*] *crenistris*, *G.* [*S.*] *striatum*, *G.* [*Beyrichoceras*] *calyx*).¹

Locality.—Firoda, a townland and also a hamlet, two and a half miles north-west of Castlecomer, county of Kilkenny. (The specimen probably came from Firoda colliery, in the Kilkenny coal-field, but as the only locality given is "Firoda" it is not possible to allocate the specimen with precision.)

GASTRIOCERAS CIRCUMPLICATILE, sp. nov. Plate XLIX, figs. 12 *a*, *b*, 13.

Description.—Shell small, somewhat inflated, widely umbilicated; greatest thickness at the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little less than one-third of the diameter of the shell. The number of whorls probably five or six; inclusion so nearly complete that only the edges of the inner whorls are exposed. Umbilicus rather less than one-half of the diameter of the shell in width, deep, with subangular margin. Whorl semilunate in section, the height about three-fifths of the breadth; indented to about one-half of its height by the preceding whorl. Periphery broadly convex, the central part elevated into an obscure ridge; the narrow lateral area somewhat flattened, merging in the periphery. The ornamentation is very elaborate, and therefore difficult to give an adequate conception of by means of a description. It consists of a series of acute transverse ribs bordering the umbilicus and radiating therefrom, with a decided inclination towards the aperture. These ribs, which only extend to the width of the lateral area, give rise to a series of fine, raised, crenulated lines; the latter generally bifurcate twice in taking their course from the ribs across the periphery. The space between each set of bifurcating lines is filled up with from three to four simple lines, which do not, like the ribs, spring from the edge of the umbilicus, but from a point nearly on a level with the bifurcating lines just described. Thus there is a space left between the ribs devoid of any transverse lines; but this space is not quite smooth, for it is occupied by the fine spiral lines, here much stronger, that cover the whole test. The direction taken by the transverse lines upon the surface of the test is as follows:—Starting from the ribs, they curve first forwards and then more sharply backwards, forming a deep and some-

¹ "The Carboniferous Ammonoids of America," 'U.S. Geol. Surv.' Mon. xlii, 1903, pp. 1—211, 29 plates. (Author's abstract in 'Geologisches Centralblatt,' Bd. iii, No. 13, p. 680.)

what broad sinus upon the periphery. Constrictions to the number of two or three to a whorl are present; these are rather inconspicuous upon the test, but make deep grooves in the cast, their course following that of the transverse lines.

Dimensions.

	Specimen from the "Cliffs of Moher" in the Dublin Mus. Sci. and Art (Geol. Surv. Coll.) (No. 4801 K).		
Diameter of shell	.	.	22.0 mm.
„ umbilicus	.	.	8.5 „
Height of outer whorl	.	.	10.0 „
„ above preceding whorl	.	.	7.0 „
Thickness at umbilical margin	.	.	11.0 „

Affinities.—While there can be no doubt that a somewhat close relationship exists between the present species and *G. Marianum*, de Vern., the distinctness of the two species is made manifest by contrasting their proportions. These may be best realised if thrown into a tabular form:

<i>Gastrioceras circumplicatile.</i>	<i>Gastrioceras Marianum.</i>
Umbilicus about two-fifths of the diameter of the shell in width.	Umbilicus about three-fifths of the diameter of the shell in width.
Breadth and height of whorl nearly equal.	Breadth of whorl about two and a half times its height.
Thickness of the shell about one-half of its diameter.	Thickness of the shell about two-thirds of its diameter.
Height of outer whorl not quite one-half of the diameter of the shell.	Height of outer whorl about one-third of the diameter of the shell.

It is in the ornamentation of the shell that a striking similarity between the two species is noticeable, the most prominent feature being the elongated tubercles or plications decorating the margin of the umbilicus, from which arise the series of beautiful curved lines crossing the sides and peripheral area of the shell. These ornaments are common to both species, and give them a very distinctive character.

Except in the great width of the umbilicus and in its having marginal ornaments, there is no special resemblance between the present species and *G. Listeri*, nor between the latter and *G. Marianum*, as urged by de Verneuil.¹

Karpinsky² compares *G. Marianum* with *G. Jossæ*, pointing out the more prominent character of the spiral ribs in the latter, and the greater width of the umbilicus in *G. Marianum*. But the marginal ornaments in *G. Jossæ* are much more prominent both in the young and in the adult than they are in *G. Marianum* and *G. circumplicatile*; they also early develop into strong tubercles. Neither in *G.*

¹ 'Géologie Russe d'Europe,' vol. ii, Paléont., 1845, p. 369, pl. xxvii, figs. 2 a—c.

² 'Mém. Acad. Imp. Sci. St. Pétersbourg' (7), vol. xxxvii, 1889, p. 49, pl. iv, figs. 2 a—c.

Marianum nor in *G. circumplicatilis* does this take place; in these the plications encircling the umbilicus are not in any sense tubercular.

Under the name *Goniatites creuistria*, W. H. Bailly¹ has confounded together at least three species from Foynes Island, including the one under description, and some of his figures can only with difficulty be identified with the specimens they are intended to represent.

Localities.—Lisdoonvarna (No. K. 495, Geol. Surv. Coll.), "Cliffs of Moher" (Nos. K. 4801 and 4802), county of Clare; Foynes Island (Nos. 824 C. and 842 C.), county of Limerick.

Family—PROLECANITIDÆ.

GENUS PROLECANITES, *Mojsisovics*, 1882 (emend. Hyatt, 1883).

PROLECANITES COMPRESSUS, *J. Sowerby*, sp. Plate XLVIII, figs. 4 *a—c*, 5 *a*, *b*, 6, 7, 8 *a*, *b*.

1813. ELLIPSOLITES COMPRESSUS, *J. Sowerby*. Min. Conch., vol. i, p. 84, pl. xxxviii.
1820. AMMONITES HENSLOWI, *J. Sowerby*. Ibid., vol. iii, p. 111, pl. clxii.
1821. — — — In Henslow's "Observations to Dr. Berger's Account of the Isle of Man," Trans. Geol. Soc., vol. v, pt. 2, p. 493.
1822. AMMONELLIPSITES COMPRESSUS, *J. Parkinson*. Introd. Foss. Org. Rem., pp. 164 and 233.
1825. CERATITES HENSLOWI, *de Haan*. Monog. Ammon. et Goni., p. 157.
- PLANITES COMPRESSUS, *de Haan*. Ibid., p. 93.
1828. NAUTILUS COMPRESSUS, *J. Fleming*. Hist. Brit. Anim., p. 231.
- AMMONITES HENSLOWI, *J. Fleming*. Ibid., p. 240.
1832. — — — *L. von Buch*. Phys. Abhandl. d. k. Akad. d. Wissenschaft. zu Berlin für 1830, p. 171, pl. ii, fig. 1.
1836. GONIATITES HENSLOWI, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 236, pl. xx, fig. 39.
1842. — — — *d'Archiac and de Verneuil*. Trans. Geol. Soc. (2), vol. vi, p. 329.
1843. — — — *J. Morris*. Cat. Brit. Foss., p. 179.
- NAUTILUS COMPRESSUS, *J. Morris*. Ibid., p. 182.
1844. GONIATITES DISCUS, *F. McCoy*. Synops. Carb. Foss. Ireland, p. 13, pl. ii, fig. 6.
1848. — HENSLOWI, *J. G. Cumming*. Isle of Man, p. 127.
- *H. G. Bronn*. Gesch. d. Natur, vol. iii, p. 542.
- SPURIUS (pars), *H. G. Bronn*. Ibid., vol. iii, p. 545.
1850. AGANIDES HENSLOWI, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 115.

¹ 'Geol. Surv. Ireland,' Explan. Sheet 142 of the Maps, 1860, pp. 11—13, figs. 2 *a—m*.

1850. NAUTILUS COMPRESSUS, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 110.
1852. AMMONITES HENSLOWI, *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 451.
- NAUTILUS COMPRESSUS, *C. G. Giebel*. Ibid., p. 178.
1854. GONIATITES COMPRESSUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 303.
- NAUTILUS (DISCITES) COMPRESSUS, *J. Morris*. Ibid., p. 308.
1855. AGANIDES HENSLOWI, *F. McCoy*. Brit. Pal. Foss., p. 564.
1881. GONIATITES HENSLOWI, *C. Barrois*. "El marmol amigdalóide de los Pirineos," Boletín de la Comisión del Mapa geológico de España, vol. viii, 1881, p. 9, pl. c, figs. 3 a—c.
1882. PROLECANITES HENSLOWI, *E. von Mojsisovics*. Abhandl. der Kais.-Kön. geol. Reichsanst., vol. x, p. 199.
1884. — — — *K. A. von Zittel*. Handb. d. Paläont., vol. ii, p. 421.
- "Ammonites Henslowi, L. von Buch," *E. Beyrich*. Zeitschr. Deutsch. geol. Gesell., vol. xxxvi, p. 210.
1888. GONIATITES HENSLOWI, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 311.
- DISCITES COMPRESSUS, *R. Etheridge*. Ibid., vol. i, Palæozoic, p. 310.
1889. PROLECANITES HENSLOWI, *E. Holzapfel*. Palæont. Abhandl., Dames und Kayser, vol. v, i, p. 42, pl. iii, fig. 14; pl. iv, figs. 2, 4, 7.
1891. DISCITES COMPRESSUS (pars), *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 91.
1892. GONIATITES (PROLECANITES) HENSLOWI, *J. Seunes*. Comptes Rendus, vol. cxv, p. 681.
1894. PROLECANITES COMPRESSUS, *A. H. Foord and G. C. Crick*. Geol. Mag. (4), vol. i, p. 11, pl. i.
1895. — — — *G. C. Crick*. Trans. Manchester Geol. Soc., vol. xxiii, pt. 3, p. 83; woodcut, p. 86.
- — — HENSLOWI, *K. A. von Zittel*. Grundzüge der Paläont., p. 400.
1897. — — — COMPRESSUS, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. Brit. Mus., pt. 2, p. 252, fig. 121.
1901. — — — *Wheelton Hind and J. A. Howe*. Quart. Journ. Geol. Soc., vol. lvii, p. 349, etc.
1902. — — — *Wheelton Hind*. Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 296: "Life-zones in the Carboniferous Rocks."

Description.—"Shell discoidal, compressed, evolute, widely umbilicated; greatest thickness at about the middle of the lateral area, about one-fourth of the diameter of the shell. Whorls seven or eight; inclusion almost nil; umbilicus shallow, about two-fifths of the diameter of the shell in width. Whorl subtrapezoidal in section, higher than wide; scarcely indented by the preceding whorl; periphery flattened, feebly convex in the middle, but slightly concave near each margin, with prominent subangular margins; sides flattened, feebly convex, becoming more inflated on the body-chamber; inner area fairly well defined, slightly convex, sloping towards the

umbilicus. Body-chamber occupying at least half of a whorl. Chambers rather shallow, fourteen or fifteen in a whorl. . . . Test thin, nearly smooth, with obscure lines of growth, which form a shallow sinus on the lateral area, and a broad, shallow sinus on the periphery." ('Cat. Foss. Ceph.,' loc. cit.)

Affinities.—On comparing this species with *Prolecanites ceratitoides*, von Buch, it is found to have more rapidly increasing whorls, and it also differs from the latter in its suture-line, in which the peripheral lobe is infundibuliform instead of being expanded posteriorly as it is in von Buch's species. The present species is distinguished from *P. similis*, Crick,¹ (1) by its more rapidly increasing whorls, (2) by the presence of the conspicuous angular lobe on the inner area of the whorl.

Remarks.—Although a full account of the history of this species was given by Mr. G. C. Crick and myself in the 'Geological Magazine' for January, 1894 (see synonymy above), it will be useful to recapitulate at least the substance of it, which is as follows:—J. Sowerby described in the 'Mineral Conchology' (vol. i, 1813) a cephalopod which he named *Ellipsolites compressus* without expressing any definite opinion at the time as to its affinities. Most succeeding writers have classed it from its general form either with *Nautilus* or with *Discites*. In looking over Mr. Wright's collection of fossils at Belfast, I was struck by the marked external resemblance of certain specimens to Sowerby's *Ellipsolites compressus*, one of them showing very clearly the suture-line characteristic of *Prolecanites*. On comparing this with Sowerby's two type specimens in the British Museum, it was found that the smaller one of the latter showed unmistakable traces of the same sutural characters, thus establishing the connection between these and Mr. Wright's specimens, while indicating at the same time their generic position. The character of the septa in these forms naturally suggested a further comparison with such species as were known to possess a similar septation; among these the "*Ammonites Henslowi*" of J. Sowerby was carefully examined, and proved to be identical with "*Ellipsolites compressus*;" thus both these names became synonyms of *Prolecanites compressus*, the specific name "*compressus*" being adopted in virtue of its priority over "*Henslowi*," which was employed by Sowerby seven years later. It is interesting to note that the specimens to which J. Sowerby gave the name *Ammonites Henslowi* came from the well-known Carboniferous deposits at Scarlet in the Isle of Man, where casts of the species appear to be tolerably abundant. As it has been recognised also from the Carboniferous Limestone of Asturias in Spain,² its geographical range is fairly extensive.

The specimen numbered "6" on Pl. XLVII claims attention on account of its being almost completely undistorted. This I consider to be the individual specimen

¹ 'Trans. Manchester Geol. Soc.,' vol. xxiii, 1895, pt. 3, p. 80; woodcut, p. 87. Also 'Cat. Foss. Ceph. British Museum,' part 3, 1897, p. 259, fig. 124 (suture-line).

² 'Cat. Foss. Ceph. Brit. Mus.,' 1897, pt. 3, p. 254.

named "*Goniatites discus*" by M'Coy, and figured in the "Synopsis," pl. ii, fig. 6, in which, like some other figures in the plates of that work, it has been reversed by the lithographer, who has also left out the rock in which it is partly embedded. In the figure of the suture-line given by M'Coy (loc. cit.) it is represented as having a divided first lateral lobe, but a careful examination of the specimen shows that such is not the case, but that the first lateral lobe terminates in a single point; and further, that the peripheral lobe is not V-shaped, as M'Coy represents it to be, but is shaped somewhat like the lateral lobes, being slightly contracted above, expanded below, and terminating in a rather acute point.¹

I may here supply an omission in the diagnosis of the species, and that is that in the adult shell a very conspicuous rim or keel is present at the angles of the periphery on each side. I would further mention the occurrence of "epidermids," seen on the concave impressed zone of the antiperipheral area of the large specimen figured on Pl. XLVIII, fig. 4a (here reduced to about one-half of the natural size), on a part of the body-chamber which, owing to a fracture, can be detached from the specimen. These epidermids consist of short, rather coarse, interrupted, transverse, impressed, wavy lines, which become finer and more pit-like at the ridges bounding the area referred to. The condition of the fossil is such that they cannot be definitely made out on the sides of the body-chamber; but on the periphery, near its subangular margin, their punctate character can be distinctly seen.

The features of this interesting species are, I think, well displayed upon the plate, and my only regret is that, owing to want of space, I was obliged to represent fig. 4a one-half its natural size. Fig. 7 is the suture-line of a specimen from the Isle of Man, and is intended to show the peripheral lobe which is not preserved in the Cork specimen (4c). The figures of the suture-lines are drawn full size.

The largest specimen known to me is a fragment which I obtained at Little Island, near Cork; it is now in the Museum of Science and Art, Dublin; it has become elliptical by pressure, the longest diameter measuring about 200 mm.; other measurements would be scarcely trustworthy owing to the great distortion of this specimen. A somewhat smaller individual from the same locality, with more nearly normal proportions, has a height of body-whorl of 56 mm. at a position probably not far from the aperture.

Localities.—Cork (city); Little Island, Blackrock, and Middleton, near the city of Cork; Ballynabointra, county of Cork (East Riding); "Four miles east of Loughrea," county of Galway.

¹ 'Geol. Mag.,' dec. 4, vol. i, Jan., 1894, p. 11: "On the Identity of *Ellipsolites compressus*, J. Sowerby, with *Ammonites Henslowi*, J. Sowerby;" by A. H. Foord and G. C. Crick.

APPENDIX.

CONTENTS.

	PAGE
<i>Temnocheilus coronatus</i>	206
<i>Solenocleilus clausus</i> (with remarks on <i>Solenocleilus</i>)	207
<i>Brancoceras Enniskillenense</i>	208
<i>Glyphioceras</i> , sp.	209
<i>Glyphioceras</i> , sp.	209
<i>Glyphioceras</i> , sp.	210
Synopsis of Families, Genera, and Species	210
Concluding Remarks, etc.—	
I. Palæontology	220
II. Geology	224
Divisions of the Carboniferous System of Ireland	225
Alphabetical List of Localities and Horizons	225
Errata	227
Index of Families, Genera, Species, etc., contained in the Monograph	229

Genus TEMNOCHEILUS (see *ante*, p. 49).

TEMNOCHEILUS CORONATUS, *F. M'Coy*. Plate XLIX, figs. 15 *a*, *b*. (Also *ante*, p. 49, Plate XVIII, figs. 1, 2.)

By great good luck a fine specimen of this species has been found in the quarries of Little Island, near Cork, where the original specimen was obtained more than half a century ago. The present specimen¹ is much larger than the type, and, unlike the latter, it is only very slightly distorted, as a glance at the figure shows.

The inner whorls, hidden by the matrix in the M'Coy specimen, are completely exposed in the new one. The sutures are seen here and there both in the inner

¹ This has been very skilfully separated from the rock by its present possessor, Mr. James Duffy, of Dublin, to whom the author is indebted for the loan of it. Mr. Duffy's success in the frequently difficult and delicate operation of freeing fossils from a refractory matrix without injuring them, added to his keen eye for rarities, has already contributed much to the enrichment of the palæontological collections in Dublin and elsewhere.

and outer whorls; they are 6 mm. apart where the sides of the shell have a breadth of 16 mm., and 8 mm. apart where the latter has increased to 21 mm. The principal dimensions of the shell are as follows:—Diameter 115 mm., height of outer whorl near the aperture 35 mm., breadth of peripheral area at the same place 55 mm., breadth of umbilicus 57 mm., diameter of its central vacuity 11 mm. The test bears no trace of ornamentation except in the first whorl, where fine and rather distant longitudinal ridges are developed.

Genus SOLENOCHEILUS (see ante, p. 126).

SOLENOCHEILUS CLAUSUS (see ante, p. 130).

When describing this species only one specimen was available, and as the siphuncle was not to be seen in it I felt doubtful as to its belonging to *Solenocheilus*. This doubt is removed by the information supplied by a small specimen that lately passed through my hands in which the position of the siphuncle is characteristically peripheral. This specimen is from the same locality, Little Island, near Cork, as the original one. A large crushed and distorted specimen from this locality in Mr. James Duffy's collection measures 223 mm. in the longer diameter of the ellipse into which it has been drawn out. It has a deep and wide hyponomic sinus in the aperture.

Remarks.—During the preparation of this part of the present Monograph I have been favoured by Dr. E. von Mojsisovics with a copy of the supplementary part of his valuable memoir on the Cephalopoda of the Hallstätter Kalke (in 'Das Gebirge um Hallstat,' Abtheilung 1, Band i, Supplement Heft, Wien, 1902). The opportunity is thus afforded me of referring to it in connection with the genus forming the subject of this addendum.

In the "Phylogeny of an Acquired Characteristic" (extr. from 'Proc. Amer. Phil. Soc.,' vol. xxxii, No. 143, Aug. 20, 1894) Professor Hyatt established the genus *Syringoceras* for the group of *Nautilus barrandei*, E. v. Mojs., to include "Triassic species like the type, *Syringoceras granulosostrictus*, which have a tubular, nepionic volution with the siphuncle subventran [marginal as to the periphery]. The early nepionic [immediately post-embryonic] shell is also ornamented with very closely set transverse ridges, but it has no longitudinal ridges until a comparatively late stage. This nepionic ornamentation is like that of the genus *Heroceras* at the same age. The impressed zone is present only after contact, and is not deep."

Dr. von Mojsisovics accepts this genus (p. 214 of his work above quoted), but includes in his synonymy of it "*Solenocheilus* (Meek and Worthen), Foord" ('Cat. Foss. Ceph. Brit. Mus.,' pt. 2, p. 165), without any reference to Hyatt's amended diagnosis of *Solenocheilus* in the 'Geological Survey of Texas' ("Carboniferous Cepha-

lopods;" Fourth Annual Report, 1892, p. 460), which I append here for comparison with that of *Syringoceras*:—"The whorl increases very rapidly by growth, and the living chambers are short, with flaring apertures. The venter [peripheral area] is elevated and gibbous, the lateral zones more or less gibbous, and the umbilical shoulders tend to project in heavy ridges extending to and modifying the form of the aperture. The dorsum in the young often till a late stage may have no impressed zone. The sutures have broad, shallow ventral lobes, corresponding saddles at the umbilical shoulders, and lobes on the dorsum with small annular lobes. The siphuncle is ventral."

I think there are few palæontologists who would not, as I do, regard the differences between *Solenocœilus* and *Syringoceras* as of sufficient importance to justify their separation, the only essential character in which they are in agreement being the peripheral situation of the siphuncle.

That Professor Hyatt had no idea of suppressing *Solenocœilus* in favour of *Syringoceras* is shown by his having again introduced it in Eastman's translation of Dr. von Zittel's 'Text-book of Palæontology' (p. 525), where he allots it a position in the family Solenocœilidæ, along with other allied genera. *Syringoceras* he places in his family Grypoceratidæ, which embraces the two Triassic genera *Syringoceras* and *Grypoceras*.

Dr. von Mojsisovics closes his generic description of *Syringoceras* by stating that it ranges from the Muschelkalk to the Carinthian stage (beds with *Trachyceras Aonoides*), but it is obvious that if *Solenocœilus* were merged in *Syringoceras* the range of the latter would extend not from the Muschelkalk only, but from the Carboniferous.

Looking at the matter from another point of view; even if a fusion of the two genera were justifiable, *Solenocœilus* having the priority would have to be retained at the expense of *Syringoceras*.

Genus BRANCOCERAS (see *ante*, p. 131).

BRANCOCERAS ENNISKILLENENSE, sp. nov. Plate XLVII, figs. 3 *a*, *b*.

Description.—Shell (? young) discoidal, compressed, umbilicated; greatest thickness at the umbilical margin; height of outer whorl about three-tenths of the diameter of the shell. Whorls (? number); inclusion nearly complete; umbilicus deep, rather wide, with angular margin and very steep sides. Whorl oval in section, apparently a little higher than wide. Periphery broadly rounded in the very young shell (Pl. XLVIII, figs. 3 *a*, *b*), subangular, with a slight keel, at a more advanced stage of growth (Pl. XLVII, fig. 3 *a*). Sides somewhat flattened around the umbilicus, more rounded in the peripheral region. Extent of the body-chamber unknown. Chambers, known only in the very young shell, rather wide

apart, but the peripheral (external) lobe is of such a length that the apex is invaginated in the opening of the preceding lobe, thus bringing the septa into close connection at this point. Test ornamented in all stages of growth with very delicate, apparently imbricating, transverse striae, which are perfectly distinct, and are therefore an important specific feature. After leaving the border of the umbilicus they form a broad forwardly directed curve, and then bending backwards make rather a deep hyponomic sinus upon the periphery. Very faint and distinct lines of growth appear upon the cast of the body-chamber. The narrow periphery is produced into a slight keel. Shallow and slightly undulating constrictions appear on the young shell.

Affinities.—This species is readily distinguished from other Carboniferous species of *Brancoeras* by its form and ornamentation. In the former the most remarkable feature is the angularity of the periphery.

Remarks.—This species was labelled "*Goniatites excavatus*" on the tablet to which it was affixed, and I at first accepted this interpretation of its affinities, but in looking more closely at it I found that the sutures were clearly and sharply defined upon the hollow mould left by the removal of the innermost whorls in extracting the fossil from the rock. An inspection of them left no doubt as to their being those of *Brancoeras*, and according to this view I have allocated the specimen, with a specific name derived from the locality in which it was found.

Locality.—Black Lion, near Enniskillen, county of Leitrim.

GLYPHIOCERAS ? sp. Plate XLIII, figs. 4 *a*, *b*.

The specimen here figured in two aspects is a cast without any trace of the test remaining upon it. I had at first assigned it to *G. mutabile*, J. Phillips, but its immature condition and the absence of any characters which could connect it definitely with that species induces me after all to leave it unnamed as the wiser course.

Locality.—Cregg, near Nobber, county of Meath.

GLYPHIOCERAS ? sp. Plate XLVIII, figs. 2, *a*, *b*.

This is the cast of the body-chamber of a small shell, which is partly embedded in the matrix. The shell is compressed, with a narrowly rounded periphery and rather flattened sides. The umbilicus is wide and deep, with steep sides having angular margins. The inclusion leaves very little of the inner whorls exposed. The ornamentation consists of very delicate imbricating transverse striae. The diameter of the shell is about 26 mm., while that of the umbilicus is 11 mm., thus about two-fifths. As the suture-line is not seen the generic position of this shell is doubtful.

Locality.—Black Lion, near Enniskillen, county of Leitrim.

GLYPHIOCERAS? sp. Plate XLVIII, figs. 3 *a*, *b*.

This small fragment of a rather widely umbilicated shell, the inner whorls of which are minutely and regularly striated transversely, is very difficult to determine specifically. It bears some resemblance to *G. stenolobum*, J. Phillips, but the umbilicus is proportionally larger, and it is a more inflated shell than the latter. As I cannot recognise in it the young of any species known to me I have not ventured to name it.

Synopsis of Families, Genera, and Species contained in this Monograph, with descriptions of the Families and Genera; the new species marked with an asterisk.

SUB-ORDER—NAUTILOIDEA.

Family—ORTHOCERATIDÆ, M'Coy, 1844.

Longicones and Brevicones, with cylindrical siphuncles and widely separated septa. Body-chamber large; aperture with an entire peristome.

Genus ORTHOCERAS (*Breyn*, 1732).—Shell straight or slightly curved; elongate-conical; circular or subelliptical in cross-section. Septa concave, usually horizontal, sometimes slightly oblique. Siphuncle of variable dimensions; cylindrical; central or excentric; calcareous deposits sometimes present. Septal necks short or reaching to the next septum. Body-chamber large; aperture entire, scarcely ever contracted; sometimes with a constriction below it. Surface of test frequently with transverse or longitudinal ornaments (annulations, ribs, striæ, etc.).

Cambrian to Trias.

A. LONGICONES.

I. Group LÆVIA. (*Species with smooth test.*)

Sub-group CYLINDRIFORMES. (*Species with cylindrical siphuncle.*)

- | | |
|----------------------------------|-----------------------------|
| 1. Orthoceras Leinsterense.* | 7. Orthoceras cylindraceum. |
| 2. „ variabile.* | 8. „ Nervense. |
| 3. „ Colei.* | 9. „ amabile (?). |
| 4. „ Nolani.* | 10. „ calamus. |
| 5. „ Sancti-Doulaghi.* | 11. „ Porteri.* |
| 6. „ acre.* | 12. „ venabulum.* |
| 13. Orthoceras perapproximatum.* | |

Sub-group MONILIFORMES. (Species with moniliform siphuncle.)

14. *Orthoceras Hindei*.* 15. *Orthoceras subclavatum*.* 16. *Orthoceras pilum*.*

II. Group ANNULATA. (Species with transverse annulations.)

17. *Orthoceras laevigatum*.

III. Group ANGULATA. (Species with longitudinal ridges.)

18. *Orthoceras Wrightii*.

IV. Group LINEATA. (Species with fine transverse or longitudinal lines.)

19. *Orthoceras Kildarensis*.* 21. *Orthoceras Hibernicum*.*
20. „ *salvum*. 22. „ *pulcherrimum*.*

V. Group IMBRICATA. (Species with imbricating striae.)

23. *Orthoceras Clanense*.* 25. *Orthoceras multistriatum*.*
24. „ *Sollasi*.* 26. „ *perellipticum*.*

B. BREVICONES.

27. *Orthoceras perconicum*.*

Family—ACTINOCERATIDÆ, Saemann, 1854.

Longicones and Brevicones with large nummuloidal siphuncle, and endosiphuncle; the latter usually with calcareous deposits, and connected by tubuli with the wall of the siphuncle.

Genus ACTINOCERAS (Bronn, 1837).—Shell straight, elongate-conical; cross-section circular to subcircular. Septa usually more arcuate than in *Orthoceras*; necks (funnels) very short. Siphuncle very large, the diameter sometimes amounting to half that of the shell; much inflated between the septa, forming a series of segments of a compressed-globular shape, with calcareous wall; often contracted by crystalline deposits secreted about the necks (“anneaux obstructeurs” of Barrande). Between these deposits runs longitudinally the endosiphuncle (prosiphon), which has a distinct wall and gives off at intervals a number of radiating canals or tubuli which reach and penetrate the wall of the siphuncle. The siphuncle forms, as in *Endoceras*, the

conical initial chamber of the shell, but is perforated just above the apex by a large foramen.

Cambrian to Carboniferous.

28. *Actinoceras giganteum*. 29. *Actinoceras insulare*.* 30. *Actinoceras propinquum*.*

Family—CYRTOCERATIDÆ, Chapman, 1857.

Longicones and Brevicones with curved shell and short, often compressed body-chamber. Siphuncle nummuloidal, usually filled with radiating deposits. Aperture with an entire peristome.

Genus CYRTOCERAS (Goldfuss, 1832).—Shell curved, tapering rapidly (brevicones), or more slowly (longicones); cross-section elliptical, ovate, or circular. Siphuncle moderately large, nummuloidal, generally situated near the convex (ventral) curvature of the shell, usually with well-developed radiating deposits or obstruction-rings. Body-chamber short; aperture simple. Septa greatly elevated towards the ventral side owing to the curvature of the shell.

Cambrian to Permian.

Sub-genus MELOCERAS (Hyatt, 1883).—Shell compressed, generally with a marked curvature only in the apical region. Section broadly ovate to elliptical. Siphuncle nummuloidal, external (exogastric), internal (endogastric), or, more rarely, sub-central (mediogastric). Body-chamber usually short, with a tendency to contraction towards the aperture in some species.

31. *Cyrtoceras* (*Meloceras*) *apicale*.* 32. *Cyrtoceras* (*Meloceras*) *arcuatoseptatum*.*

Genus EUSTHENOCERAS (*Foord*, 1898).—Shell large, typically curved only in the apical portion. Septa at first approximate, afterwards becoming very widely separated. Sutures arching upwards on the dorsal or inner curvature of the shell. Siphuncle subcentral in the direction of the ventral region, apparently cylindrical.

Carboniferous.

33. *Eusthenoceras* *Hulli*. 34. *Eusthenoceras* *Bailly*.

Family—POTERIOCERATIDÆ, *Foord*, 1888.

Fusiform, slightly curved shells, inflated in the middle, with slender apex. Sutures often oblique to longitudinal axis; siphuncle moniliform, with an endo-siphuncle in adult stage. Aperture with the peristome entire.

Genus POTERIOCERAS (McCoy, 1844).—Shell fusiform, the curvature slight, very slender in the apical portion, inflated in the middle, contracting towards the aperture, which is simple. Cross-section nearly circular in the young, elliptical in the adult. Siphuncle subcentral to marginal, moniliform. Body-chamber proportionately large, constricted near the aperture. Test smooth.

Ordovician to Carboniferous.

35. *Poterioceras fusiforme*.

36. *Poterioceras latiseptatum*.^{*}

37. *Poterioceras ventricosum*.

Family—TAINOCERATIDÆ, Hyatt, 1883 (emend. 1893, 1900).

Discoïdal, whorls usually robust, trapezoidal in section at some stage of growth, or throughout life, tuberculated; sutures without annular lobe; siphuncle small and cylindrical.

Genus TEMNOCHEILUS (McCoy, 1844).—Shell subdiscoïdal, umbilicus generally large and deep. Periphery broad and flattened. Whorls usually but little embracing; cross-section trapezoidal at all stages of growth. One row of nodes on each side of the periphery-lateral margin.

Carboniferous.

38. *Temnocheilus coronatus*.

Family—TRIGONOCERATIDÆ, Hyatt, 1883 (emend. 1893, 1900).

Whorls subtriangular at some stage of growth or throughout life, often with longitudinal ridges; body-chamber sometimes free near the aperture. Annular lobe rarely present. Siphuncle small, submarginal.

Genus TRIGONOCERAS (McCoy, 1844).—Shell rapidly tapering, the apical part forming half a volution (*vide* McCoy), the rest gently curving. Cross-section scutiform. Peripheral area distinctly concave; anti-peripheral edge carinated. Siphuncle subcentral in the direction of the peripheral area. Obtuse longitudinal ridges occur at the peripheral angles.

Carboniferous.

39. *Trigonoceras paradoxicum*.

Genus CÆLONAUTILUS (Foord, 1891, emend. Hyatt, 1893).—Shell compressed-discoïd, deeply umbilicated. Cross-section subtriangular. Peripheral area very broad,

often with more or less prominent ridges. Siphuncle subcentral in the direction of the periphery to nearly marginal.

Carboniferous.

GROUP OF *CÆLONAUTILUS PLANOTERGATUS*.

40. *Cælonautilus planotergatus*.

41. *Cælonautilus Doohylensis*.*

42. *Cælonautilus gradus*.*

Genus STROBOCERAS (*Hyatt*, 1883, emend. 1893).—Shell compressed-discoid, with elevated peripheral area and prominent ridges separated by furrows on the sides.

Carboniferous.

GROUP OF *STROBOCERAS SULCATUM*.

43. *Stroboceras sulcatum*.

44. *Stroboceras crassum*.*

Genus APHELECERAS (*Hyatt*, 1883, emend. 1893).—Shell compressed-discoid. Cross-section subhexagonal. Peripheral area very narrow, sulcated more or less deeply. Umbilical vacuity large; the first whorl generally completed before the succeeding one touches it. Young shell with lateral and ventral longitudinal ridges.

Carboniferous.

GROUP OF *APHELECERAS MUTABILE*.

45. *Apheleceras mutabile*.

46. *Apheleceras Hibernicum*.

47. *Apheleceras trochlea*.

Genus MESOCHASMO CERAS (*Foord*, 1900).—Shell discoidal, much compressed. Whorls slowly tapering, narrow, with a very large umbilical vacuity. Cross-section subhexagonal. Periphery slightly channelled. No ornamentation at any stage of growth.

Carboniferous.

48. *Mesochasmoceras latidorsatum*.

Genus DIORUGOCERAS (*Hyatt*, 1893).—Shell with more compressed whorls than those of *Apheleceras*. Periphery channelled. Involution almost complete in the adult. (This genus is represented by only one species, and is not satisfactorily defined.)

Carboniferous.

49. *Diorugoceras planidorsatum*.

Family—TRIBOLO CERATIDÆ, *Hyatt*, 1883 (emend. 1893, 1900).

Whorls similar to those of *Trigonoceratidæ*; periphery may be concave or convex; annular lobe in all genera except *Coloceras*.

Genus TRIBOLO CERAS (*Hyatt*, 1883, emend. 1893).—Shell discoid. Cross-section subhexagonal. Periphery with a broad, elevated, median zone in the adult. Prominent ridges on the sides and periphery, which are often rendered subspinous by the coarse transverse lines of growth.

Carboniferous.

50. *Triboloceras formosum*.*

Genus VESTINAUTILUS (*Ryckholt*, 1852, emend. *Hyatt*, 1883, 1893).—Shell thick-discoid. Cross-section subhexagonal. Apparently smooth and rounded in the very young stage of growth. Periphery broadly rounded, with more or less distinct ridges both on the sides and periphery, tending to become obsolete in the adult or senile stage. Thick nodes are sometimes present upon the latero-peripheral angles of the body-chamber in adult shells.

Carboniferous.

51. *Vestinautilus semiglaber*.*

52. „ *crassimarginatus*.*

53. „ *cariniferus*.

54. „ „ *var. magnicameratus*.*

55. „ „ *var. triplicatus*.*

56. *Vestinautilus crateriformis*.*

57. „ *paucicarinatus*.

58. „ *pinguis*.

59. „ *semiplicatus*.*

60. „ *multicarinatus*.

Genus PLANETOCERAS (*Hyatt*, 1893).—Shell subglobose. Cross-section pentagonal in the adult, thus differing from *Triboloceras* and *Vestinautilus*. Body-chamber partly free from the rest of the shell; greatly depressed and laterally expanded.

Carboniferous.

61. *Planetoceras globatum*.

Genus COLOCERAS (*Hyatt*, 1893).—Shell thick-discoid, section subquadrangular. Periphery with numerous ridges in the early stages of growth and two elevated zones on each side of a median depression.

Carboniferous.

62. *Coloceras Cayanum*.

63. *Coloceras bistriale*.

Family—RHINOCERATIDÆ, Hyatt, 1893 (emend. 1900).

Whorls stout, tetragonal in section, with convex periphery; longitudinal ridges are developed; annular lobe present in most genera.

Genus THRINCOCERAS (Hyatt, 1893).—Shell thick-discoid, typically large. Cross-section subhexagonal. Periphery broad and depressed. Test covered with close-set spiral ridges.

Carboniferous.

64. Thrincoceras Hyatti.*

65. Thrincoceras Hibernicum.

Genus DISCITOCERAS (Hyatt, 1883, emend. 1893).—Shell compressed-discoid. Sides and periphery flattened. Outline of aperture distinctly sigmoid. Longitudinal ridges present in the young shell.

Carboniferous.

66. Discitoceras Leveilleanum.

68. Discitoceras costellatum.

67. „ Wrightii.*

69. „ ? discors.

Genus PHACOCERAS (Hyatt, 1883, emend. 1893).—Shell typically discoid, much compressed. Cross-section narrowly sagittate. Periphery acutely angular. Young having apparently the form and proportions of *Discitoceras* at that stage.

Carboniferous.

70. Phacoceras oxyostomum.

71. Phacoceras ? rectisuturale.*

Family—SOLENOCHEILIDÆ, Hyatt, 1893 (emend. 1900).

Whorls may be open or closed; depressed elliptical or broadly hemispherical in outline; umbilical zone very broad; shell smooth; some species have spinose, others wing-like projections at the margin of the aperture proceeding from the umbilical rim.

Genus AIPOCERAS (Hyatt, 1883, emend. 1893).—Shell rapidly increasing, with an open coil. Cross-section subtriangular. Whorls compressed at the sides, flattened on the dorsal aspect. Test smooth.

Carboniferous.

72. Aipoceras compressum.

73. Aipoceras ? Hainesianum.*

Genus ACANTHONAUTILUS (Foord, 1896).—Shell *Nautilus*-like, subglobose, with somewhat flattened peripheral area. Umbilicus rather large, funnel-shaped, with a

thickened rim which is produced on each side into a long, flat, spine-like process projecting nearly at right angles to the longitudinal axis of the shell.

Carboniferous.

74. *Acanthonautilus bispinosus*.

Genus ASYMPTOCERAS (*Ryckholt*, 1852, emend. *Hyatt*, 1893).—Shell *Nautilus*-like, with subquadrate whorls. Body-chamber contracted in some species; the aperture may have the inferior border thickened into a prominent lip, or there may be a distinct inflation just below this border. Siphuncle at the margin of the periphery just beneath the test.

Carboniferous.

75. *Asymptoceras crassilabrum*.*

76. *Asymptoceras Foordi*.

Genus SOLENOCHEILUS (*Meek and Worthen*, 1870, emend. *Hyatt*, 1883, 1893).—Shell *Nautilus*-like, subglobose. Cross-section broadly sagittate. Periphery elevated and rather narrowly rounded, the umbilical angles of the aperture projecting on each side. Siphuncle marginal as in *Asymptoceras*.

Carboniferous.

77. *Solenocheilus dorsalis*.

78. *Solenocheilus* ? *Hibernicus*.

79. *Solenocheilus clausus*.[†]

SUB-ORDER AMMONOIDEA.

Family—GLYPHOCERATIDÆ, *Hyatt*, 1883 (emend. *J. Perrin Smith*, 1897; *Hyatt*, 1900).

[Sub-order *Eurycampyli*, *Hyatt*, 1900 (pars), in *Eastman's* transl. of von *Zittel's* 'Grundz. d. Palæont.']

Shells of variable form, including highly involute ones and also some with open umbilicus exposing all the inner whorls. Septa concave along the median line of the periphery in *Branco CERAS*, the primitive form, convex in the mature stages of other genera; peripheral lobe entire in primitive forms, but becoming divided in more specialised genera; lateral saddle simple or, very rarely, divided by a second lateral lobe. Siphuncle small; septal necks short, usually with a forwardly-directed collar.

Genus BRANCO CERAS (*Hyatt*, 1883).—Shell involute, discoidal and compressed; umbilicus narrow or closed; surface of test smooth or with fine transverse ribbing;

suture-line—peripheral lobe¹ deep and undivided, peripheral saddles² rounded; lateral lobes narrow and deep, lateral saddles broadly rounded.

Upper Devonian and Carboniferous.

80. *Brancoceras ornatissimum*.

81. *Brancoceras Enniskillenense*.*

Genus PERICYCLUS (*Mojsisovics*, 1882, emend. *Hyatt*, 1883).—Shell involute, subglobose to compressed, narrowly to widely umbilicated; surface of test with strong, direct, transverse ribs, forming a shallow sinus on the periphery, but usually without any sinuosity on the sides of the shell; constrictions present in some species; suture-line—peripheral lobe divided by a small median saddle;³ peripheral saddles broadly rounded or spatulate; lateral lobes pointed, deep; lateral saddles broadly rounded, or forming a shallow arch; usually with a small auxiliary lobe at the umbilicus.

Carboniferous.

82. *Pericyclus funatus*.

88. *Pericyclus trapezoidalis*.

83. „ *fasciculatus*.

89. „ *Bailyi*.

84. „ *Doohylensis*.

90. „ *rotuliformis*.

85. „ *multicostatus*.*

91. „ *plicatilis*.

86. „ *Foordi*.

92. „ *Clanensis*.

87. „ *subplicatilis*.

93. „ *Leesoni*.

Genus GLYPHIOCERAS (*Hyatt*, 1883, emend. *J. Perrin Smith*, 1897).—Shell involute, globose to compressed; umbilicus usually narrow or closed; periphery strongly convex to subacute; surface of test smooth or finely striated, often with periodic constrictions; suture-line—peripheral lobe divided by a small median saddle; peripheral saddles narrow, rounded or pointed; lateral lobes acute or subacute, deep; lateral saddles broadly rounded or obtusely angular; usually with a small auxiliary lobe at the margin of the umbilicus.

Carboniferous and Permo-Carboniferous.

Sub-genus SPHENOCERAS,⁴ sub-gen. nov. (= *Glyphioceras*, Section I [pars], of *Hyatt*).—Shell involute, globose, with narrow or closed umbilicus, the whorl semilunate in section; surface of test longitudinally or spirally striated, with periodic constrictions; suture-line—peripheral lobe with a prominent median saddle dividing it into two acute terminations; peripheral saddles inclined towards the umbilicus, often acute; lateral lobes acute or very narrowly rounded; lateral saddles broadly rounded, sometimes with a subacute apex.

94. *Sphenoceras sphaericum*.

95. *Sphenoceras crenistria*.

96. *Sphenoceras striatum*.

¹ Known also by the names “outer,” “external,” and “ventral” lobe.

² Known also as the “lateral” saddle or “first lateral” saddle.

³ Called also the “siphonal” saddle.

⁴ Referring to the wedge-shaped peripheral saddles and lateral lobes.

Sub-genus BEYRICHOCERAS, sub-gen. nov. (= *Glyphioceras*, Section II [pars], of Hyatt).—Shell involute, usually compressed, with rounded, sometimes depressed periphery, umbilicus variable, generally small. Surface of test usually smooth or only marked with lines of growth, rarely with transverse ribbing or with spiral striæ. Suture-line resembling that of *Sphenoceras*, but with the peripheral saddles rounded or linguiform, never acutely pointed; peripheral lobe usually shallow, median saddle small and larval in shape; lateral lobes acutely to obtusely pointed, sometimes mucronate; lateral saddles broadly rounded, when less so the apex points towards the peripheral saddle on each side.

97. <i>Beyrichoceras obtusum</i> .	106. <i>Beyrichoceras micronotum</i> .
98. „ <i>truncatum</i> .	107. „ <i>diadema</i> .
99. „ <i>subtruncatum</i> .*	108. „ <i>reticulatum</i> .
100. „ <i>occidentale</i> .*	109. „ <i>subreticulatum</i> .*
101. „ <i>difficile</i> .*	110. „ <i>bilingue</i> .
102. „ <i>subquadratum</i> .*	111. „ <i>Davisi</i> .
103. „ <i>sphæroidale</i> .	112. „ <i>cordatum</i> .
104. „ <i>Browni</i> .	113. „ <i>pulchellum</i> .*
105. „ <i>corpulentum</i> .	114. „ <i>spirale</i> .

Sub-genus MUENSTEROCERAS (Hyatt, 1883).—Shell globose to subglobose and compressed; umbilicus of variable dimensions; whorls higher than wide; surface of test with more or less regular lines of growth, or with reticulate lines. Suture-line—peripheral lobe deep, often with subparallel sides; the median saddle small as in *Beyrichoceras*; peripheral saddles rounded or spatulate; lateral lobes acutely to obtusely pointed; lateral saddles broadly rounded, or forming a wide-spreading shallow arch.

115. <i>Muensteroceras crassum</i> .*	116. <i>Muensteroceras ellipsoidale</i> .
117. <i>Muensteroceras obesum</i> .*	

Genus GASTRIOCERAS (Hyatt, 1883, emend. Karpinsky, 1889).—Shell globose or subcompressed, with trapezoidal cross-section, usually widely umbilicated, whorls numerous, periphery broadly rounded. Surface of test with longitudinal striæ, or with transverse ribs, the umbilical margin usually bearing tubercles or tubercular ribs; constrictions often present; suture-line—peripheral lobe broad and sometimes with mucronate terminations (*G. Jossæ*, e. g.), divided by a broad and elevated median saddle; peripheral saddles broadly rounded, or spatulate; first lateral lobes deep, linguiform, with mucronate extremities in some species; second lateral lobes small, angular, situated upon the umbilical margin, or upon the inner (umbilical) area; lateral saddles sometimes broadly, sometimes narrowly rounded or spatulate.

Carboniferous and Permo-Carboniferous.

118. <i>Gastrioceras circumnodosum</i> .*	119. <i>Gastrioceras circumplicatile</i> .*
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Family—PROLECANITIDÆ, *Hyatt*, 1883 (emend. *Karpinsky*, 1890; *Hyatt*, 1900).

[Sub-order *Phyllocampyli*, *Hyatt*, 1900 (pars), in *Eastman's* transl. of von *Zittel's* 'Grundz. d. Palæont.']

Discoidal or involute, compressed, subquadrate, or helmet-shaped in section. Primitive forms with undivided peripheral lobe; more specialised forms with hastate lobes and saddles and divided peripheral lobe.

Genus PROLECANITES (*Mojsisovics*, 1882; emend. *Hyatt*, 1883, 1900).—Shell discoidal, compressed, evolute, widely umbilicated, with a narrow, sometimes flattened periphery. Surface of test smooth or striated. Suture-line—saddles entire, narrowly rounded, constricted near the base, giving them a hastate appearance; lobes obtusely pointed; peripheral lobe undivided; two or three lateral lobes; auxiliary lobes absent or few in number; inner (antiperipheral) lobe narrow, deep, pointed, with a flat, broad, rounded lobe on each side of it.

Devonian and Carboniferous.

120. *Prolecanites compressus*.

CONCLUDING REMARKS.

I. PALÆONTOLOGY.

In C. R. *Eastman's* translation of von *Zittel's* 'Grundzüge der Palæontologie' (1900) a new scheme of classification of the Cephalopoda is introduced, the work of the late Professor *Hyatt*, which, though partly embodying the older scheme of the well-known 'Genera of Fossil Cephalopods' (1883), contains important modifications, involving the erection of many new sub-orders, groups, families, and genera. The scheme is complicated and somewhat defective as it stands; type species of the new genera are often omitted, while in other cases though the type species is named there is no description of the genus. An enumeration of typical forms would have greatly lessened this defect. We are told, however, in a note by the translator that "the classification and diagnoses are condensed from an exhaustive monograph on fossil Cephalopods, at present still in MS., which embodies the results of his [*Hyatt's*] life-study." The deficiencies referred to may

therefore be found to be remedied to a large extent in the complete work, the publication of which, owing to the lamented death of its accomplished author, has naturally lapsed, we trust only for a time.

As the greater part of the present Monograph had appeared before Eastman's 'Translation' was published, I was unable to make use of Hyatt's revised classification contained in it, which is here briefly outlined. As in the 'Genera of Fossil Cephalopods,' the structure of the siphuncle constitutes the leading feature of the larger divisions (sub-orders) of the Nautiloidea. Those forms having long septal necks or "funnels" which completely close the spaces between the septa, HOLOCHOANITES, include *Endoceras*, *Piloceras*, and other genera. Under the sub-order MIXOCHOANITES, *Choanoceras*, *Ascoceras*, *Mesoceras*, etc., are placed. *Conoceras*, with some other aberrant genera, is put into the sub-order SCHISTOCHOANITES. ORTHOCHOANITES includes a great number of genera, of which only a few can be named: *Orthoceras*, *Lituites*, *Clydonautilus*, *Vestinautilus*, *Hercoceras*, *Solenoceras*, *Acantho-
nautilus*, *Nautilus*, and many others. Under CYRTOCHOANITES (in which the shortness of the septal necks is the leading feature), *Loxoceras*, *Actinoceras*, *Ooceras*, *Poterio-
ceras*, *Gomphoceras*, *Phragmoceras*, and other genera are comprised.

In the Ammonoidea we are here concerned only with the primitive group of the Goniatites; these are arranged by Hyatt, together with the Ammonites, under new sub-orders, as follows:—*Gastrocampyli*¹ (= *Clymenia* of former systems), *Microcampyli*, *Mesocampyli*, *Eurycampyli*, *Glossocampyli* (= Goniatites [excepting Prolecanitidæ] of former systems), *Discocampyli* (= Ceratites of former systems), *Phyllocampyli* (including Prolecanitidæ, Noritidæ [Waagen], Medlicottidæ), *Leptocampyli*, *Pachycampyli* (= Ammonites of former systems).

Gastrocampyli is the equivalent of von Zittel's *Intrasiphonata*; the rest of the sub-orders are naturally included in his *Extrasiphonata*.

The method of arrangement of the species described in this Monograph may now be explained. The subdivisions of the Orthoceratidæ proposed by Hyatt in his provisional classification contained in the 'Genera of Fossil Cephalopods,' and founded mainly upon the external features of the shell, its ornamentation, shape, etc., met with only partial acceptance, owing to the difficulty of strictly limiting the genera, especially when forms of a transitional character had to be dealt with. It was therefore not adopted in this Monograph, in which the Orthoceratidæ are primarily divided into *Longicones* and *Brevicones*,² the former being again divided into groups and sub-groups according to the ornamentation of the test and the structure of the siphuncle. In this group the septation appears to be the least useful of the characters to be employed to differentiate its various elements, the

¹ "The suffix *campylus*, signifying curve, in the names of the sub-orders, is used wholly with reference to the saddle inflections as they appear in the typical forms of each group."

² Barrande, 'Syst. Sil. de la Bohême,' vol. ii, Texte, 1^{ère} Partie, Rech. Pal., 1867, p. 8.

simplicity of form in these cylindrical shells being accompanied by a correspondingly simple form in the septa. It is noticeable that Hyatt makes no direct reference to the septation in defining his sub-orders, families, and genera of the Nautiloidea in Eastman's 'Translation,' but depends rather upon the nature of the septal necks and the siphuncle and its contents, if any, taking into account likewise characteristic ornamentation.

The arrangement of the remaining groups of the Nautiloidea (exclusive of the Actinoceratidæ, Cyrtoceratidæ, and Poterioceratidæ) follows in the main that of Hyatt's "Carboniferous Cephalopods," contributed to the 'Geology of Texas, Fourth Annual Rep.' (1892), with such modifications as it became necessary to make in the presence of the new material available.

For the Ammonoidea, here represented by the Goniatites, Hyatt's widely recognised classification has been adopted, though in the case of the largest and most important group, the Glyphioceratidæ, some changes have been introduced. Under his original description of *Glyphioceras* Hyatt divided the genus into two sections which he characterised, and to which he allotted certain species. To these unnamed sections I have given distinctive names as sub-genera, and following Perrin Smith,¹ have resuscitated *Muensteroceras*, also as a sub-genus, taking the suture-line in each case as the principal distinguishing feature (Synopsis of Families, Genera, etc., p. 219).

The retention of *Gastrioceras* as an independent genus, rather than the merging of it in *Glyphioceras*, as suggested by Karpinsky,² is held by Perrin Smith to be justified by the fact that *Gastrioceras* being a later branch than *Glyphioceras*, phylogenetic studies are facilitated by their separation, while there is no difficulty in distinguishing typical members of each group. *Gastrioceras* is therefore maintained in accordance with this view.

The most cursory survey of the material at present collected and recorded shows plainly what a rich molluscan fauna is contained in the rocks of the Carboniferous System spread over a great part of Ireland. It is a safe prediction that with more workers in the field much additional material might be gathered in, thereby greatly facilitating those studies which may lead to the most important results in all that relates to the phylogeny of the Cephalopoda, and the important biological and faunal questions they help to elucidate; for, as it has been truly stated, "the Cephalopoda alone, of all animals, preserve in the individual a complete record of their larval and embryonic history, the protoconch and early chambers being enveloped and protected by the latter stages of the shell."³ Hence the great importance that must be attached to the collection of many individuals of the same species to supply the means of carrying out such embryological work as has already

¹ 'Proc. California Acad. Sci.,' third ser., Geology, vol. i, No. 3, p. 105, 1897.

² 'Mém. Acad. Imp. Sci. St. Pétersbourg,' vol. xxxvii, p. 48, 1889.

³ J. Perrin Smith, in 'Proc. Amer. Phil. Soc.,' vol. xxxv, 1896, p. 254.

been productive of very interesting results. I refer here especially to Perrin Smith's fruitful studies in the phylogeny of the Glyptioceratidæ.

It may excite some surprise in those who make use of this work that some of the species of Cephalopoda contained in the lists of Irish Carboniferous fossils published by McCoy,¹ Kelly,² Baily,³ and others, are entirely omitted from its pages. This omission has been found necessary (1) in cases in which the type specimen has been lost and the description found to be insufficient for purposes of identification, (2) more often when the identification of a species has been entirely mistaken. The latter applies to some of the species in the Griffith Collection to which names have been affixed without sufficient discrimination (*see* foot-note, p. 197). This has been rectified whenever the material was sufficiently well preserved to supply the data necessary for determining the species.

In comparing the Cephalopod fauna of the Belgian Carboniferous area with that of the British Isles, one cannot fail to notice how few species there are which are common to both. Considering the proximity of the two areas, this is remarkable and difficult to account for, except on the assumption that the physical conditions differed to such an extent as to give a distinctive specific facies, expressed in differing species in the respective areas.

Without having recourse to comparative tables it may be noted that the species common to the British Isles and Belgium are generally those which are at the same time the most abundant and characteristic of their kind in each area. Such species, *e.g.*, among the Nautiloids are *Orthoceras lævigatum*, F. McCoy; *Actinoceras giganteum*, J. de C. Sowerby; *Stroboceras sulcatum*, J. de C. Sowerby, sp.; *Discitoceras Leveilleanum*, L. G. de Koninck, sp.; *Apheloceras mutabile*, F. McCoy, sp.; *Vestiantilus paucicarinatus*, A. H. Foord. Among the Goniatites the following species may be enumerated in the same sense:—*Glyptioceras* (*Sphenoceras*) *striatum*, J. Sowerby, sp.; *G. (S.) sphaericum*, W. Martin, sp.; *G. (Beyrichoceras) truncatum*, J. Phillips, sp.

Of the rarer forms occurring in both areas the following may be cited:—*Trigonoceras paradoxicum*, J. de Sowerby, sp.; *Tenuocheilus coronatus*, F. McCoy.

Out of 126 species of Cephalopods described by de Koninck ('Calc. Carb.') only about 26 can be identified as occurring in the Irish area. An analysis of these figures shows that out of 52 species of the coiled Nautiloids 11 are common to Ireland and Belgium, of uncoiled ones 7 out of 41 are common to both countries, and of Goniatites 8 out of 33.

¹ 'Synopsis Carb. Foss. Ireland,' 1844.

² 'Journ. Geol. Soc. Dublin,' 1855-7, vol. vii.

³ 'Mem. Geol. Surv. Ireland.'

II. GEOLOGY.

The divisions in the Carboniferous Limestone series of Ireland, though sometimes fairly well marked lithologically, are of doubtful value for purposes of zonal palæontology, as it is a question whether the "Lower," "Middle,"¹ and "Upper" divisions, as constituted, were actually synchronous throughout the country, or whether they may not have represented deposits of different character accumulated simultaneously in different districts, and depending upon the diverse physical conditions for their dissimilarity,—in fact, upon such variable results as might have been produced by shallower or deeper water.

As regards the beds above the so-called Upper Limestone, we have it on the joint authority of Dr. Wheelton Hind and Mr. J. A. Howe² that certain beds in the counties of Dublin and Limerick, at Westown³ and on Foynes Island⁴ respectively, belong to the Upper Limestone Shales, or Pendleside Group. The characteristic fauna found in them is held to supply "strong presumptive evidence of this view." It should be added that the beds at Westown were recognised by the officers of the Geological Survey to belong to the horizon now claimed for them; those of Foynes Island were, however, assigned to the Coal Measures. The species here tabulated are in the Dublin Museum of Science and Art, in the Geological Survey Collection.

The fauna at Westown comprises the following species :

<i>Aviculopecten papyraceus.</i>	<i>Lunulicardium</i> [Footi].
" <i>variabilis.</i>	<i>Goniatis crenistria</i> [Glyph. spirale].
<i>Posidonomya membranacea.</i>	" <i>Listeri</i> . ⁵
[<i>Posidoniella levis</i> ?.] ⁵	<i>Orthoceras</i> [Steinhaueri].
	<i>Dithyrocaris.</i>

¹ Called also "Calp," a local term originally employed by Kirwan. This rock is a dark-coloured, or black, earthy limestone of a shaly or flaggy character.

² 'Quart. Journ. Geol. Soc.,' 1901, vol. lvii: "On the geological succession and palæontology of the beds between the Millstone Grit and the Limestone-Massif at Pendle Hill, and their equivalents in certain other parts of Britain," p. 376.

³ 'Mem. Geol. Surv. Ireland,' Expl. sheets 102 and 112, 2nd ed., 1875, p. 60.

⁴ Ibid., Expl. sheet 142, 1860, pp. 8—15.

⁵ The names between square brackets were added by Dr. Wheelton Hind.

⁶ The specimens labelled "Coal Measures, Westown, co. Dublin—*Goniatis Listeri*," are too much crushed to be specifically recognisable, but there are features in them which would amply suffice to exclude them from that species; one of these is a very distinct spiral groove or sulcus in the outer whorl, recalling *Glyphioceras bilingue*; the inner whorls are transversely ribbed. There are other fragments on the surface of the shale with tubercular ribbing; these last may have suggested affinities with *Gastrioceras Listeri*, but I am unable to confirm this view, the presence of the sulcus being fatal to it and rather supporting the idea of a species with compressed whorls. No trace of the suture-line is seen in any of the specimens that I have met with in these shales.

The fauna on Foynes Island is as follows :

<i>Posidonomya Becheri.</i>	<i>Goniatites</i> [<i>Glyphioceras</i>] ¹ <i>reticulatus.</i>
<i>Aviculopecten papyraceus.</i>	„ <i>Listeri</i> [<i>Gastrioceras circumplicatile</i>].
<i>Orthoceras minimum.</i>	<i>Nautilus tuberculatus</i> [?].

The following divisions of the Carboniferous System of Ireland are those at present recognised by the Geological Survey, but it seems to be admitted that some of them need revision, and this they will doubtless undergo in course of time.

Middle Coal Measures.

Lower Coal Measures.

Millstone Grit.

Yoredale Series.

Upper Carboniferous Limestone.

Middle „ „

Lower „ „

Lower Limestone Shale or Basement Beds.

The list given below supplies the localities and horizons of the fossils described. I am indebted to Mr. Alexander M'Henry, M.R.I.A., and to Mr. Henry J. Seymour, B.A., F.G.S., for kindly verifying these, the former from the official registers, the latter from the geological maps.

Alphabetical List of the Localities referred to in the foregoing Descriptions of Fossils, with their Horizons.

<i>Place.</i>	<i>County.</i>	<i>Horizon.</i>
Ardgoul South	Limerick	Lower ² Limestone.
Ardlaman	„	„ „
Ardtomin	„	„ „
Ballinacourty	Waterford	„ „
Ballycahane	Limerick	„ „
Ballyduff (Dungarvan)	Waterford	„ „
Ballynabointra	Cork (East Riding)	„ „
Ballynacarriga	Limerick	„ „
Ballyrichard	Cork	„ „
Bantry	„	„ „
Black Lion	Leitrim	Upper Limestone.
Blackrock (two miles east of Cork)	Cork	Lower Limestone.
Caher Lane	Limerick	Lower Coal Measures (Ganister).
Carnteel	Tyrone	Lower Limestone.

¹ The names, etc., between square brackets are added by the writer.

² The word "Carboniferous" after Lower, Middle, and Upper (Limestone) is omitted for the sake of brevity.

<i>Place.</i>	<i>County.</i>	<i>Horizon.</i>
Castle Espie	Down	Lower Limestone
Clane	Kildare	" "
Cliffs of Moher	Clare	Lower Coal Measures (Ganister).
Cloghran (two miles south of Swords)	Dublin	Lower Limestone.
Clonmel	Tipperary	" "
Cookstown	Tyrone	" "
Courtclough	Dublin	Middle Limestone.
Cragard	Limerick	Lower Limestone.
Cregg (near Nobber)	Meath	Upper Limestone.
Crosspatrick (Killala)	Mayo	Lower Limestone.
Curraghbridge (near Adare)	Limerick	" "
Derryloran	Tyrone	" "
Doneraile	Cork	" "
Doohyle (near Rathkeale)	Limerick	" "
Doon, Mt. Phelim (near Kilfendra)	Clare	Millstone Grit.
Drumsra (near Drumquin)	Tyrone	Middle Limestone.
Enniskillen (near the town)	Fermanagh	Lower Limestone.
Fanningtown	Limerick	" "
Florencecourt	Fermanagh	Middle Limestone.
Foynes Island	Limerick	Yoredale.
Garrihies	Kerry	Lower Limestone.
Garristown	Dublin	Middle Limestone.
Glenbane	Limerick	Lower Limestone.
Glenbane East	"	" "
Kilkommooh	Longford	" "
Killorglin	Kerry	" "
Kilmacat	Limerick	" "
Kilmallock	"	" "
Kinsale	Cork	Yoredale.
Lisbane	Limerick	Lower Limestone.
Lisdoonvarna	Clare	Coal Measures.
Lisnakerry	Limerick	Lower Limestone.
Little Island	Cork	" "
Loughrea (four miles east of)	Galway	" "
Loughshinny	Dublin	Upper Limestone, or Yoredale ?.
Milleteon	Cork	Lower Limestone.
Mullaghfarry	Mayo	" "
Mullaghtinny (near Clogher)	Tyrone	" "
Naas	Kildare	" "
Nantenan	Limerick	" "
Newtown	Dublin	Middle Limestone.
Oldtown	Queen's	Lower Limestone.
Paget Priory (near Maynooth)	Meath	Yoredale.
Rathcabill	Limerick	Lower Coal Measures (Ganister).
Rathfarnham	Dublin	Middle Limestone.
Rathkeale	Limerick	Lower Limestone.
Ring	Fermanagh	" "

<i>Place.</i>	<i>County.</i>	<i>Horizon.</i>
Saint Doulagh's	Dublin	Lower Limestone.
Samphire Island	Kerry	Upper Limestone.
Shrule (near Ballymahon)	Londonderry	Lower Limestone.
Summerhill	Meath	Upper Limestone.
Tankardstown (near Kildorrery)	Cork	Lower Limestone.
Tomdeely	Limerick	" "
Townparks (near Killeshandra)	Cavan	" "

I cannot close this Monograph without expressing my sincere thanks to the authorities of the Geological Survey, the Museum of Science and Art, and the Royal College of Science for Ireland, for the loan of the fossils under their charge. Their kindness and liberality in placing the necessary material freely at my disposal, and also their indulgence to me in the matter of time, have greatly facilitated the completion of my task.

To the authorities of the British Museum (Natural History) I am equally indebted for their courtesy in according me all possible facilities for the study and illustration of the fossils contained in the Geological Department applicable to this Monograph.

ERRATA.

Part ii, 1898, p. 28, line 14 from top, insert *Locality*.—Claue, county of Kildare.

" " p. 33, line 7 from bottom, insert —*Genus* CYRTOCERAS, *Goldfuss*, 1832.

Part iii, 1900, p. 60, line 18 from bottom, for Pl. XX, figs. 1—4, read Pl. XXVII, figs. 1—4.

" " p. 97, line 13 from bottom, for "contracted" read "depressed."

" " p. 118, line 17 from top, for vol. ix, read vol. iv.

" " Plate XX, *Stroboceras sulcatum*, the numbering of figs. 11 and 12 require to be transposed.

INDEX.

Note.—Names of species which are regarded as synonyms or as invalid (and the pages on which they occur), whether contained in the tables of references or elsewhere in the text, also any species merely referred to incidentally in the text, are printed in *italics*.

- ACANTHONAUTILLUS, 118, 121, 122, 216, 221
 bispinosus, 118, 121
 cornutus, 121
- ACTINOCERAS, 28, 32, 211, 221
Bigsbyi, 32
 giganteum, 28, 29, 30, 31, 32, 223
 insulare, 30, 31, 32, 33
 propinquum, 33
 pyramidatum, 28
Simmsii, 28
- ACTINOCERATIDÆ, 28, 211, 222
- Aganides :
 diadema, 179
 fasciculatus, 136
Henslowi, 202, 203
 micronotus, 177
 obtusus, 163
 reticulatus, 183
 sphaericus, 155, 173
 sphaericus, var. β crenistria, 158
 striatus, 157, 160
 striolatus, 179
 subfurcatus, 135
 truncatus, 165
- AIPOCERAS, 116, 131, 132, 216
 compressum, 116
 gibberosum, 117
 Hainesianum, 131
- Ammonellipsites :
 compressus, 202
 funatus, 134
- Ammonites, 221
 carbonarius, 154
 diadema, 179, 180
Henslowi, 68, 202, 203, 204, 205
 Listeri, 136, 179
 micronotus, 177
 princeps, 134
 reticulatus, 183
 sphaericus, 154, 155, 158, 160, 163, 173
 spiralis, 191
 striatus, 157, 160, 161
 truncatus, 165
- AMMONOIDEA, 132, 217
- ANGULATA, 16, 211
- ANNULATA, 14, 211
- APHELECERAS, 65, 72, 73, 118, 214
 difficile, 67
- APHELECERAS—
 discoideum, 67, 70
 exaratus, 71
 Hibernicum, 68, 70
 mutabile, 65, 66, 67, 68, 69, 70, 223
 trochlea, 67, 70, 71, 72
- Apioceras :
 fusiforme, 43
- APPENDIX, 206
- Asoceras, 221
- ASYMPTOCERAS, 117, 122, 123, 124, 217
 conspicuum, 125
 crassilabrum, 122, 123, 125, 132
 dorsale, 126
 Foordi, 123, 124
- BEYRICHOCERAS, s.g. (*see* Glyphioceras), 163, 177, 219
 bilingue, 186
 Browni, 175
 cordatum, 188
 corpalentum, 176
 Davisi, 187
 diadema, 179
 difficile, 171

BEYRICHO CERAS—

- miconotum*, 177
- obtusum*, 163
- occidentale*, 170
- pulehellum*, 190
- reticulatum*, 182
- sphaeroidale*, 173
- spirale*, 191
- subquadratum*, 172
- subreticulatum*, 191
- subtruncatum*, 168
- truncatum*, 165

BRANCO CERAS, 132, 134, 208,
209, 217

- Enniskillenense*, 208
- ornatissimum*, 132
- rotatorium*, 133

BREVICONES, 27, 211, 221

Cephalopoda, 223*Ceratites*, 221

Henslowi, 202

Choanoceras, 221*Clydonautilus*, 221*Clymenia*, 221CLODONAUTILUS, 50, 53, 59, 70,
72, 84, 118, 213

bistrialis, 115

cariniferus, 82

Doehylensis, 56

globatus, 96

gradus, 55, 57, 59

hexagonus, 55

multicarinatus, 93

paucicarinatus, 86

pinguis, 89

planotergatus, 53, 54, 55, 56,
58, 59

subsulcatus, 59

COLOCERAS, 113, 114, 215

bistriale, 114, 115, 116

Coyanum, 113, 114, 116

globatum, 114

Conchylolithus Nautilites sphaer-
icus, 154

Concluding Remarks :

I. Palaeontology, 220

II. Geology, 224

Conoceras, 221

Coya, 123

Cryptoceras :

dorsalis, 126

Cycloceras :

levigatum, 14

CYLINDRIFORMES, 1, 210

CYTROCERAS, 15, 17, 33, 36, 37,
38, 41, 43, 212

acinaces, 35

(*Meloceras*) *acus*, 36

aequale, 35

Antilope, 36

(*Meloceras*) *apicale*, 33, 34, 37

(*Meloceras*) *arachnoideum*, 36

(*Meloceras*) *arcuato-septatum*,
37

Baillyi, 38, 42

concinnum, 35

cornu, 35, 36

cornu-bovis, 36

dactylophorum, 15

depressum, 35

digitus, 35, 36

(*Meloceras*) *Gesneri*, 36

hircinum, 35

Hulli, 38, 39

ignotum, 35

(*Meloceras*) *imperitum*, 36

impotens, 35

miles, 35

nescium, 35

Nysti, 35

Puzosianum, 17

(*Meloceras*) *reptum*, 36

rostratum, 34, 36

(*Meloceras*) *rugosum*, 36

Scharyi, 35

(*Meloceras*) *Verneuilianum*, 36

CYTROCERATIDE, 33, 212, 222

Cyrtoceras, 221

DIORUGOCERAS, 73, 214

planidorsatum, 74

Discites, 53, 204

bisulcatus, 63

compressus, 66, 203

Discites—

costellatus, 107

discors, 104

Hibernicus, 68

mutabilis, 65

oxy stomus, 108

(*Phacoceras*) *oxy stomus*, 108

planotergatus, 53, 54

sulcatus, 60

DISCITOCERAS, 50, 102, 107, 110,
216

costellatum, 107

discors, 104, 105

Leveilleanum, 102, 103, 104,

105, 106, 223

Wrightii, 104, 105, 106, 107

Discocampyli, 221*Ellipsolites* :

compressus, 68, 202, 204, 205

ovatus, 163, 165

Ellipsolithes :

funatus, 134

Endoceras, 32, 221

EURYCAMPYLI, 217, 221

EUSTHENOCERAS, 36, 38, 41, 212

Bailly, 39, 40, 41, 42, 43

Hulli, 38, 39, 40, 41, 42

Extrasiphonata, 221

GASTRIOCERAS, 196, 198, 219

carbonarium, 197, 199, 200

circumnodosum, 196, 197, 198

circumplicatile, 200, 201, 202

coronatum, 197, 199

diadema, 180

fasciculatum, 136

Gibsoni, 183

Josse, 197, 201

Listeri, 197, 198, 199, 200, 201,
224

Marianum, 198, 201, 202

Gastrocampyli, 221*Globites* :

ovatus, 163

sphaericus, 154

striatus, 160

GLYPHIOCERAS, 154, 181, 218

(Beyrichoceras) *bilingue*, 186,
187, 188, 224(Beyrichoceras) *Browni*, 174,
175*calyx*, 200*carbonarium*, 155*complanatum*, 171(Beyrichoceras) *cordatum*,
188, 189(Beyrichoceras) *corpulentum*,
176(Münsteroceras) *crassum*, 193(Sphenoceras) *crenistris*, 157,
158, 200*cf. crenistris*, 158(Beyrichoceras) *Davisi*, 184,
187, 187, 189, 190(Beyrichoceras) *diadema*, 179,
180, 181, 182(Beyrichoceras) *difficile*, 168,
171, 172, 173(Münsteroceras) *ellipsoidale*,
194, 195, 196*excavatum*, 181, 184*Hispanicum*, 171, 172*inconstans*, 169(Beyrichoceras) *miconotum*,
177, 178*mutabile*, 209(Münsteroceras) *obesum*, 195,
196(Beyrichoceras) *obtusum*, 163,
164, 169(Beyrichoceras) *occidentale*,
168, 170*parallelum*, 194*Phillipsi*, 164, 181(Beyrichoceras) *pulchellum*,
188, 190(Beyrichoceras) *reticulatum*,
182, 183, 185, 187, 188, 189,
190, 191, 225*rotella*, 170, 171(Sphenoceras) *sphaericum*, 154,
155, 156, 162, 174, 223(Beyrichoceras) *sphaeroidale*,
173, 174

GLYPHIOCERAS—

(Beyrichoceras) *spirale*, 191,
192, 193, 224*stenolobum*, 210(Sphenoceras) *striatum*, 157,
159, 160, 161, 192, 193, 195,
200, 223(Beyrichoceras) *subquadra-*
tum, 168, 172, 173(Beyrichoceras) *subreticula-*
tum, 184, 188(Beyrichoceras) *subtrunca-*
tum, 167, 168, 169, 171(Beyrichoceras) *truncatum*,
165, 166, 167, 168, 169, 172,
173, 177, 178, 181, 223

GLYPHIOCERAS, sp., 209, 210

GLYPHIOCERATIDÆ, 132, 217

Gomphoceras, 45, 221*fusiforme*, 43, 48*lagenale*, 48*sulcatulum*, 48*Goniatites*, 193, 221, 222, 223*Baylei*, 192*Beyrichianus*, 179*bilinguis*, 186*Browni*, 152, 157, 175*crenistris*, 157, 158, 159, 183,
202, 224*diadema*, 179, 180*discus*, 202, 205*excavatus*, 209*fasciculatus*, 135, 136, 137*funatus*, 134*furcatus*, 136*Gibsoni*, 182, 183, 184*granosus*, 191, 193*Henslowi*, 202, 203(Prolecanites) *Henslowi*, 203(Pericyclus?) *impressus*, 139*jugosus*, 182, 183*Listeri*, 179, 224, 225*miconotus*, 177, 178*obtusus*, 163, 164*ornatissimus*, 132, 134*ovatus*, 163*plicatilis*, 143, 150*princeps*, 134*Goniatites*—*reticulatus*, 182, 183, 225*sphaericus*, 154, 155, 156, 157,
158, 160, 175(Glyphioceras) *sphaericus*, 155,
156*sphaericus*, var. *crenistris*, 134*sphaeroidalis*, 173, 175*spiralis*, 157, 191, 192*spurius*, 202*striatus*, 157, 158, 160, 161,
175, 191*striolatus*, 179, 180*truncatus*, 75, 165, 166(Pericyclus?) *virgatus*, 139*vittiger*, 157*Wrightii*, 151

GROUP OF—

Celonautilus planotergatus,
53Glyph. (Beyr.) *reticulatum*,
182Glyphioceras (Beyr.) *trunca-*
tum, 165*Stroboceras sulcatum*, 60*Grypoceratidæ*, 208*Gyroceras*, 51(Aipoceras) *compressum*, 116*Hibernicum*, 101*paradoxicum*, 51(Trigonoceras) *paradoxicum*,
51*Hercoceras*, 207, 221*Hercoglossa*, 110*Holotochanites*, 221

IMBRICATA, 21, 211

Intrasiphonata, 221*Leptocampyli*, 221

LINEATA, 17, 211

Lituites, 221

Localities and Horizons, 225

LÆVIA, 1, 210

LONGICONES, 1, 210, 221

Loxoceras, 221

- Medlicottidae*, 221
MELOCERAS, s.g. (*see* Cyrtoceras), 212
 apicale, 33
 arcuatoseptatum, 37
Mesocampyli, 221
Mesoceras, 221
MESOCHASMO CERAS, 72, 73, 214
 latidorsatum, 73
Microcampyli, 221
Mixochoanites, 221
MONILIFORMES, 12, 211
MUENSTEROCERAS, s.g. (*see* Glyphoceras), 177, 193, 194, 195, 219
 crassum, 193
 ellipsoidale, 194
 obesum, 196
 parallelum, 194
 reticulatum, 183
 truncatum, 166
Nautilipsites :
 ovatus, 163
Nautilites, 160
NAUTILOIDEA, 1, 193, 210, 221, 222
Nautilus, 50, 70, 123, 130, 204, 221
 atlantoides, 97
Borrandei, 207
 biangulatus, 50, 82
 bistrialis, 115
 (*Temnocheilus*) bistrialis, 115
 bisulcatus, 63
 cariniferus, 82, 86, 88
 (*Temnocheilus*) cariniferus, 82
 complanatus, 109
 compressus, 202, 203
 (*Discites*) compressus, 203
 coronatus, 120
 coronatus, 49
 (*Temnocheilus*) coronatus, 49
 (*Discites*) costellatus, 107
Coyanus, 113
 discors, 104
 (*Discites*) discors, 104
 dorsalis, 126, 127, 128, 132
Nautilus—
 excavatus, 82
Freieslebeni, 121
funatus, 134
furcatus, 137
 globatus, 96, 115, 116
 (*Temnocheilus*) globatus, 96
 hexagonus, 55
Hibernicus, 113
 latidorsatus, 73
 latus, 50
Mosquensis, 68
 multicarinatus, 86, 93
 (*Discites*) mutabilis, 65, 66
 ovatus, 163
 ozystomus, 108
 (*Discites*) ozystomus, 108
 perplanatus, 165
 pinguis, 89
 (*Temnocheilus*) pinguis, 113
 planidorsatus, 74
 planotergatus, 53
 (*Discites*) planotergatus, 53
 (*Temnocheilus*) porcatus, 93, 95
Rouillieri, 110
Seebachianus, 121
 subsulcatus, 68
 sulcatus, 60, 62, 63, 64, 75
 (*Discites*) sulcatus, 60
 sulcifer, 62
 sulciferus, 82
 trochlea, 70
 (*Discites*) trochlea, 70
 tuberculatus, 50, 225
Noritidae, 221
Oncoceras, 48
Ooceras, 221
Orbulita :
 spherica, 154
 striata, 160
Orthocera :
 cordiformis, 47
 cylindracea, 7
 fusiformis, 43
 gigantea, 28
 paradoxica, 51
ORTHOCERAS, 1, 36, 38, 41, 210, 221
 acre, 6, 10, 11
 amabile, 8
 annulatum, 14
Breguii, 13
 calamus, 9
 cinctum, 22, 26, 27
 Clanense, 21, 22, 23, 25
 Colei, 3, 4, 5,
 conquestum, 18
 cordiforme, 28
 cucullus, 27, 28
 cyclophorum, 15
 cylindraceum, 7, 11
 dactylophorum, 14
 dilatatum, 28
 discrepans, 18
 (*Loxoceras*) distans, 25
 fandum, 5
 fusiforme, 43
 giganteum, 28, 29
 (*Actinoceras*) giganteum, 28
 Hibernicum, 19, 36
 Hindei, 12, 13, 14
 inopinatum, 6
 Kildarensen, 17
 lævigatum, 14, 15, 223
 latissimum, 28, 46, 47
 Leinsterense, 1, 3, 4
 lineale, 20
 Morrisianum, 22
 multistriatum, 10, 24, 25
 Nervense, 6, 7, 8
 oblique-annulatum, 15
 paradoxicum, 51
 (*Trigonoceras*) paradoxicum, 51
 perapproximatum, 11
 perconicum, 27, 28
 perellipticum, 24, 25
 pilum, 12, 13
 Porteri, 9, 11
 princeps, 3
 pulcherrimum, 19
 Puzosianum, 16
 salutatum, 18
 saluum, 18, 18, 57

ORTHOCERAS—

- Sancti-Doulaghi, 5, 6
- Sollasi, 23, 25
- Steinhaveri, 224
- (*Actinoceras*) *striatum*, 19, 20
- subclavatum*, 12, 13, 14
- undatum*, 15
- unguis*, 33
- variabile, 2, 2
- venabulum, 10
- vicinale*, 22
- Wrightii, 16, 17

ORTHOCERATIDÆ, 1, 210

Orthoceratites:

- subfusiformis*, 48
- subpyriformis*, 48

Orthoceres brévicones, 28

Orthochoanites, 221

Pachycampyli, 221

PERICYCLUS, 134, 152, 154, 218

- Bailly, 142, 147, 148, 149
- Clanensis, 151, 152, 154
- Doolyensis, 57, 137, 138, 139, 140
- fasciculatus, 134, 135, 136, 137, 140, 151, 197
- Forrdi, 141, 142, 143, 144, 147, 148, 149
- funatus, 134, 136, 137, 151
- furcatus*, 136, 151
- Hauchecornei*, 151
- Kochi, 139
- Leesoni, 152, 153
- multicostatus, 137, 139, 140
- plicatilis, 135, 150, 151
- princeps*, 152
- rotuliformis, 142, 146, 147, 148, 149
- subplicatilis, 142, 143, 144, 148, 151
- trapezoidalis, 144, 146
- virgatus*, 152

PHACOCERAS, 108, 110, 216

- oxystomum, 108, 111, 112
- rectisuturale, 111
- Phragmoceras*, 221

PHYLLOCAMPYLI, 220, 221

Piloceras, 32, 221

PLANETOCERAS, 96, 215

- globatum*, 96, 116
- retardatum*, 97

Planites:

- compressus*, 202

POTERIOCERAS, 28, 43, 45, 48,

- 213, 221
- approxinatum*, 48
- cordiforme*, 46, 48
- ellipsoideum*, 48
- fusiforme*, 43, 44, 45, 46, 48
- heteroclitum*, 48
- latiseptatum*, 44, 45, 48
- lumbrosus*, 48
- Marri, 48
- vasiforme*, 48
- ventricosus*, 46, 48

POTERIOCERATIDÆ, 43, 212, 222

Prolecanites, 68, 154, 202, 204,

- 220
- ceratitoides*, 204
- compressus*, 202, 203
- Henslowi*, 203
- Leesoni*, 153
- similis*, 204

PROLECANITIDÆ, 220, 221

Pronorites:

- cyclolobus*, 198

Rhineceras, 102

- Hibernicum*, 101

RHINECERATIDÆ, 98, 216

Schistochoanites, 221

SOLENOCHEILIDÆ, 116, 117, 122,

- 130, 216

SOLENOCHEILUS, 117, 126, 129,

- 130, 132, 207, 208, 217, 221
- atlantoides*, 129
- clausus*, 130, 207
- conspicuus*, 124
- dorsalis*, 126, 127, 129
- evolutus*, 127, 128
- Hibernicus*, 128, 129, 131
- latiseptatus*, 127

SPHENOCERAS, s.g. (see *Glyphioceras*), 154, 218

- crenistria*, 157

SPHENOCERAS—

- sphaericum*, 154
 - striatum*, 160
- STROBOCERAS, 57, 59, 60, 73, 214
- Belgicum*, 62, 64
 - bisulcatum*, 61, 63, 64
 - cordiostomum*, 64
 - crassum*, 64
 - Edwardsianum*, 64
 - germanum*, 64
 - gradus*, 57
 - Phillipsianum*, 64
 - sulcatum*, 60, 61, 64, 65, 223

Subclymenia, 73

Synopsis of Families, Genera, and Species, 210

Syringoceras, 207, 208

- granulosostratum*, 207

TAINOCERATIDÆ, 49, 213

TEMNOCHEILUS, 49, 206, 213

- coronatus*, 49, 50, 206, 223
- crenatus*, 75, 77
- furcatus*, 136
- globatus*, 96
- multicarinatus*, 93
- pinguis*, 113
- tuberculatus*, 50

Terebrirostra, 123

THRINOCERAS, 98, 102, 216

- depressum*, 100

- Hibernicum*, 99, 101, 102

- Hyatti*, 98, 99, 100, 102

- Kentuckiense*, 99, 100

Trachyceras:

- Aonoides*, 208

TRIBOLOCERAS, 75, 77, 78, 215

- consobrinum*, 78
- formosum*, 75, 77, 78, 79
- intermedium*, 78
- Meyerianum*, 77, 78
- serratum*, 78

TRIBOLOCERATIDÆ, 75, 215

TRIGONOCERAS, 51, 52, 53, 59,

- 72, 118, 213
- aigoceras*, 52, 118
- paradoxicum*, 51, 52, 53, 118, 223

TRIGONOCERATIDÆ, 51, 72, 213

VESTINAUTILUS, 77, 78, 79, 84, 92, 114, 123, 215, 221	VESTINAUTILUS—	VESTINAUTILUS—
cariniferus, 81, 82, 84, 85, 86, 87, 88, 94, 113, 114	cariniferus, var. triplicatus, 112	paucicarinatus, 83, 84, 86, 90, 91, 92, 95, 223
cariniferus, var. magnicamera- tus, 84	cariniformis, 78, 80	punguis, 88, 89, 90, 95
	crassimarginatus, 79, 81	semiglaber, 77, 78
	crateriformis, 84, 85	semiplicatus, 91, 92
	Koninckii, 78	
	multicarinatus, 93	

PLATE XL.

PERICYCLUS BAILYI, *G. C. Crick.*

Fig. 1 *a.* Lateral view of the type specimen in which the inner whorls are concealed in the matrix. 1 *b.* Front view of the same, showing the ribbing. St. Doulagh's. British Museum (No. C. 298). (Page 147.)

Fig. 2 *a.* Lateral view of a smaller specimen in which the inner whorls are all exposed to view. From a drawing by the author. 2 *b.* Front view of the same. St. Doulagh's. Woodwardian Museum, Cambridge (No. 439). (Page 147.)

Fig. 3. Suture-line from a specimen formerly in the author's possession; reproduced from Mr. Crick's figure in the 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 439, fig. 7. St. Doulagh's. (Page 147.)

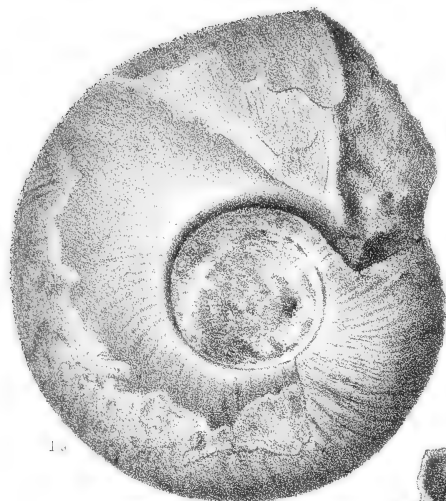
PERICYCLUS ROTULIFORMIS, *G. C. Crick.*

Fig. 4 *a.* Lateral view of the type specimen, with eroded fragments of the test adhering to the cast. 4 *b.* Front view of the same, showing two constrictions. St. Doulagh's. Dublin Museum of Science and Art. (Page 148.)

Fig. 5. Lateral view of a specimen, showing the inner whorls, with nodes. From a drawing by the author. St. Doulagh's. Woodwardian Museum, Cambridge (No. 411). (Page 148.)

Fig. 6. Peripheral view of a somewhat thicker individual than 4 *a.*, showing the characteristic constrictions very strongly marked upon the cast. St. Doulagh's. Dublin Museum of Science and Art. (Page 148.)

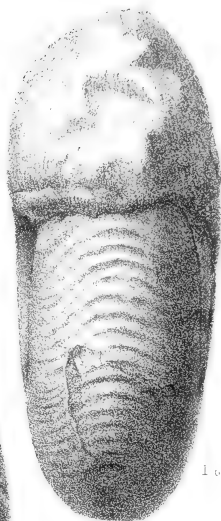
Fig. 7. Suture-line of an imperfect individual. From a drawing by the author. Glenbane. Dublin Museum of Science and Art (Geological Survey Collection—No. 716 C.). (Page 148.)



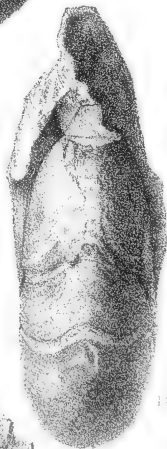
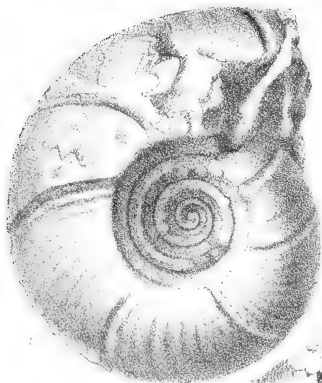
1a



2b



1b



6

7

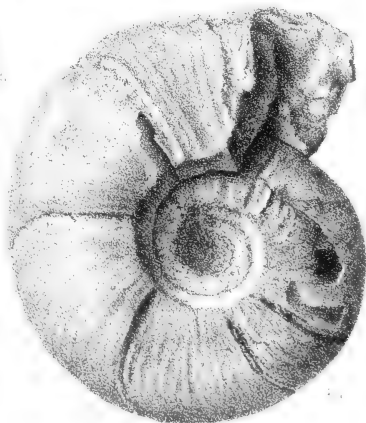
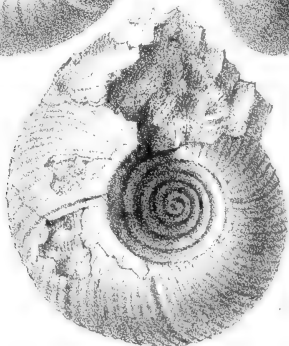


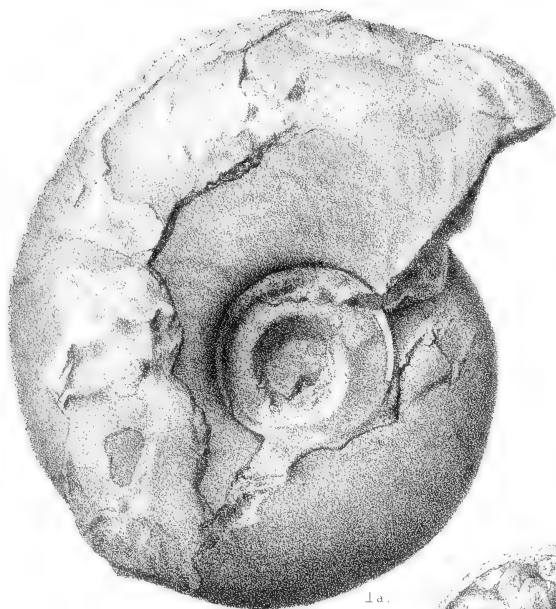
PLATE XLI.

PERICYCLUS CLANENSIS, *G. C. Crick*.

Fig. 1 *a*. Lateral view of the type and only specimen, showing fragments of the test. [The lithographer has represented the edge of the inner whorl too angular.] 1 *b*. Front view of the same. 1 *c*. Suture-line of the same. (The lateral lobe is not pointed enough.) Clane. Dublin Museum of Science and Art. (Page 151.)

PERICYCLUS Plicatilis, *L. G. de Koninck*, sp.

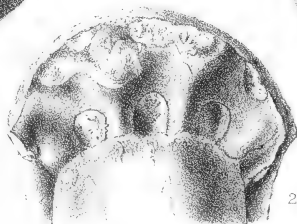
Fig. 2 *a*. Front view of the distorted type specimen. 2 *b*. Lateral view of the same. 2 *c*. Front view, showing the greater part of a septum exposed by the removal of part of the shell. From a drawing by the author. 2 *d*. Suture-line taken from 2 *c*, now covered again by the replacement of the detached portion. Kilmacat, county of Limerick. Dublin Museum of Science and Art (Geological Survey Collection). (Page 150.)



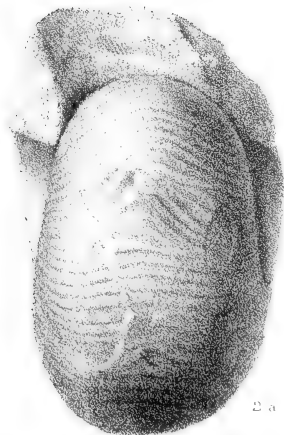
1a.



1b.



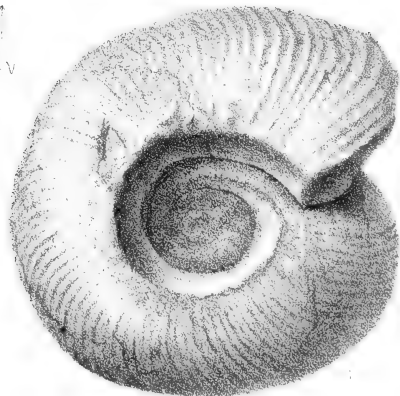
2c.



2a.



2b.



2d.

ATHollick delectat
AHFord direct



PLATE XLII.

GLYPHIOCERAS (s.-g. SPHENOCERAS) SPHERICUM, *W. Martin*, sp.

Fig. 1 *a*. Lateral view of the cast of a small specimen, showing the suture-lines with great clearness. 1 *b*. Peripheral view of the same. Near Bantry. Mr. Joseph Wright's Collection. (Page 154.)

Fig. 2. Lateral view of an entirely septate specimen, showing constrictions. Ireland (exact locality not known). British Museum (No. 25,294). (Page 154.)

GLYPHIOCERAS (s.-g. SPHENOCERAS) STRIATUM, *J. Sowerby*, sp.

Fig. 3. Periphero-lateral view of a wholly septate fragment, embedded in the rock, showing a shallow constriction. Fig. 4. Crushed specimen, showing the ornamentation and constrictions. Courtlough. Dublin Museum of Science and Art (Geological Survey Collection). (Page 160.)

GLYPHIOCERAS (s.-g. SPHENOCERAS) CRENISTRIA, *J. Phillips*, sp.

Fig. 5. Lateral view of a septate specimen with fragments of test. Ireland (exact locality not known). British Museum (Morris Collection—No. 50,183). (Page 157.)

Fig. 6. Suture-line, taken from fig. 76 of 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1897, p. 161. Bolland (Lancashire). British Museum (No. C. 5080). (Page 157.)

GLYPHIOCERAS (s.-g. BETRICHOCERAS) OBTUSUM, *J. Phillips*, sp.

Fig. 7 *a*. Lateral view of a specimen distorted into an ellipse nearly at right angles to the aperture. 7 *b*. Peripheral view of the same. 7 *c*. Suture-lines of the same. Little Island. Dublin Museum of Science and Art. (Page 163.)

Fig. 8 *a*. Lateral view of an undistorted specimen. 8 *b*. Front view of the same, showing sutures artificially exposed. 8 *c*. Suture-lines of the same. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection). (Page 163.)

Fig. 9 *a*. Lateral view of a specimen of what is probably the young of this species. 9 *b*. Front view of the same. 9 *c*. Peripheral view of the same. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection—No. 452). (Page 163.)

GLYPHIOCERAS (s.-g. MUENSTEROCERAS) CRASSUM, sp. nov.

Fig. 10 *a*. Lateral view of the type specimen distorted into an ellipse parallel with the aperture; the sutures artificially exposed. 10 *b*. Peripheral view of the same. 10 *c*. Suture-lines of the same drawn in plan to show both sides. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection—No. 547). (Page 193.)

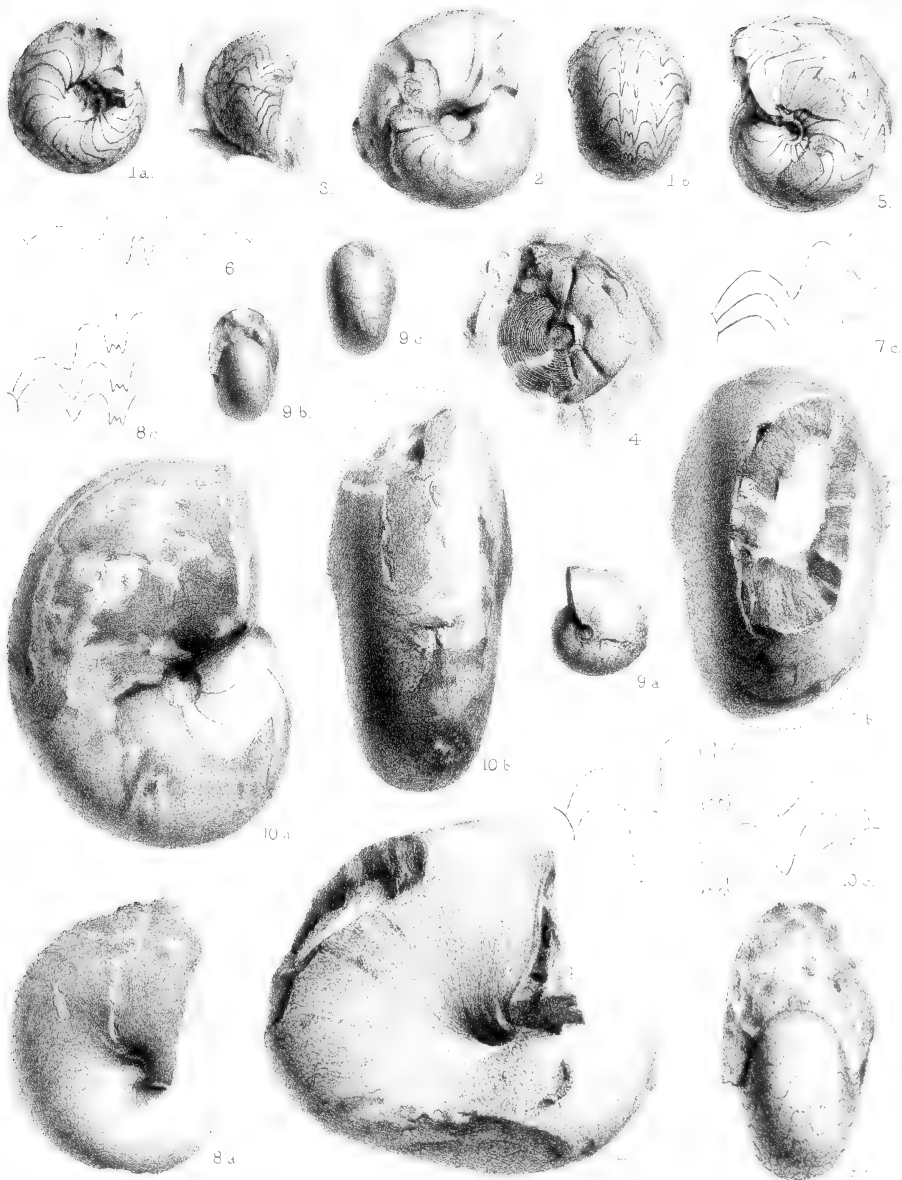


PLATE XLIII.

GLYPHIOCERAS (s.-g. MÜNSTEROCERAS) ELLIPSOIDALE, *G. C. Crick*.

Fig. 1 *a*. Lateral view of the type specimen. 1 *b*. Front view of the same. 1 *c*. Suture-line from another specimen. Dublin Museum of Science and Art. Fig. 1 *a*. Kildare (exact locality in the county unknown.) Fig. 1 *c*. St. Doulagh's. (Page 194.)

GLYPHIOCERAS (s.-g. SPHENOCERAS) STRIATUM, *J. Sowerby*, sp.

Fig. 2 *a*. Lateral view of a fine specimen with remains of the test, showing the characteristic ornamentation; the sutures and a constriction are also well displayed. [Drawn from a specimen in the British Museum from Derbyshire (No. 33,451); this is intended to supplement the very defective Irish specimens figured on Pl. XLII, the only ones available.] 2 *b*. Suture-line of this species; the lobes and saddles are made much too obtuse in this figure (compare 2 *a*), which is copied from the figure of Sowerby's type specimen ('Cat. Foss. Ceph., British Museum,' pt. 3, 1897, p. 168, fig. 78). (Page 160.)

GLYPHIOCERAS (s.-g. MÜNSTEROCERAS) OBESUM, sp. nov.

Fig. 3 *a*. Lateral view of the type specimen distorted into an elliptical form in which the longer diameter is nearly at right angles to the aperture. 3 *b*. Front view of the same, showing the sutures. 3 *c*. Suture-lines of the same, showing the invagination of the peripheral lobes. (Page 196.)

GLYPHIOCERAS, sp.

Fig. 4 *a*. Lateral view of the cast of a very small individual. 4 *b*. Front view of the same. Cregg (Nobber). Dublin Museum of Science and Art ("Griffith Collection"). (Page 209.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) TRUNCATUM, *J. Sowerby*, sp.

Fig. 5 *a*. Peripheral view of a small specimen. 5 *b*. Lateral view of the same, showing doubly curved deep constrictions on the cast; fragments of the smooth test are also present. Ballycane. Dublin Museum of Science and Art (Geological Survey Collection—No. 2963). (Page 165.)



PLATE XLIV.

GLYPHIOCERAS (s.-g. BEYRICHCERAS) TRUNCATUM, *J. Phillips*, sp.

Fig. 1 *a*. Lateral view of a large specimen, showing a faint constriction, and, more anteriorly, what appears to be the sigmoidal outline of the aperture. 1 *b*. Peripheral view of the same, showing a slight flattening in this region. Lisnakerry. Dublin Museum of Science and Art (Geological Survey Collection—No. 4124). (Page 165.)

Fig. 2 *a*. Lateral view of the cast of a large specimen, showing two distinct constrictions. 2 *b*. Peripheral view of the same. 2 *c*. Sutures of the same; the last three septa; the peripheral lobe is too narrow. Clane. Dublin Museum of Science and Art. (Page 165.)

Fig. 3 *a*. Lateral view of a cast of typical shape. 3 *b*. Peripheral view of the same, showing truncation. St. Doulagh's. Dublin Museum of Science and Art. (Page 165.)

Fig. 4 *a*. Lateral view of a nearly perfect specimen, showing the smooth test and the nearly closed umbilicus. 4 *b*. Front view of the same with the sutures artificially exposed. 4 *c*. Suture-lines of the same. Clane. Dublin Museum of Science and Art ("Griffith Collection"). [This specimen is somewhat doubtfully referred to the present species; its general features resemble those of *Glyph. obtusum*, but the sutures are more like those of the former.] (Page 165.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) MICRONOTUM, *J. Phillips*, sp.

Fig. 5 *a*. Lateral view of a small (or young?) specimen, showing the fine transverse striæ. 5 *b*. Peripheral view of the same. Kildare (exact locality in the county unknown). British Museum (No. 26,268). (Page 177.)



PLATE XLV.

GLYPHIOCERAS (s.-g. BEYRICHCERAS) TRUNCATUM, *J. Phillips*, sp.

Fig. 1 *a*. Lateral view of the cast of a young individual. 1 *b*. Front view of the same, showing sutures imperfectly. 1 *c*. Peripheral view of the same. 1 *d*. Suture-lines of the same (imperfect). St. Doulagh's. Dublin Museum of Science and Art (No. 51 *a*). (Page 165.)

Fig. 2 *a*. Lateral view of a very compressed individual, showing very distinct lines of growth near the periphery. (These are made to look too prominent and too broadly curved in the figure.) 2 *b*. Front view of the same. 2 *c*. Peripheral view of the same. Nantenan. Dublin Museum of Science and Art (Geological Survey Collection). (Page 165.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) SUBTRUNCATUM, sp. nov.

Fig. 3 *a*. Lateral view of the nearly perfect type specimen, showing the wavy lines of growth, and a few obscure spiral lines. 3 *b*. Front view of the same, with suture-lines. *c*. Peripheral view of the same. 3 *d*. Suture-lines of the same. Nantenan. Dublin Museum of Science and Art (Geological Survey Collection—No. 4712). (Page 168.)

Fig. 4 *a*. Lateral view of a young individual, showing the wavy lines of growth. The umbilicus is represented in this figure too angular; it is similar to that of 3 *a*. 4 *b*. Front view of the same. 4 *c*. Peripheral view, showing an imperfect constriction. Fanningtown. Dublin Museum of Science and Art (Geological Survey Collection—No. 1141). (Page 168.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) OCCIDENTALE, sp. nov.

Fig. 5 *a*. Lateral view of the type specimen. 5 *b*. Peripheral view of the same. 5 *c*. Suture-lines of the same. Fig. 6 *a*. Lateral view of a smaller individual, showing some faint lines of growth. (The dark line in the lower part of the figure is only a fracture.) 6 *b*. Front view of the same. Garrihies (Kerry). Dublin Museum of Science and Art (Geological Survey Collection—fig. 5 *a*, No. 4169; fig. 6 *a*, No. 3786). (Page 170.)

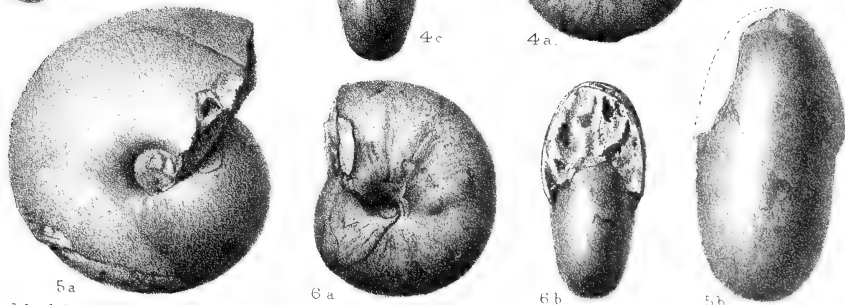
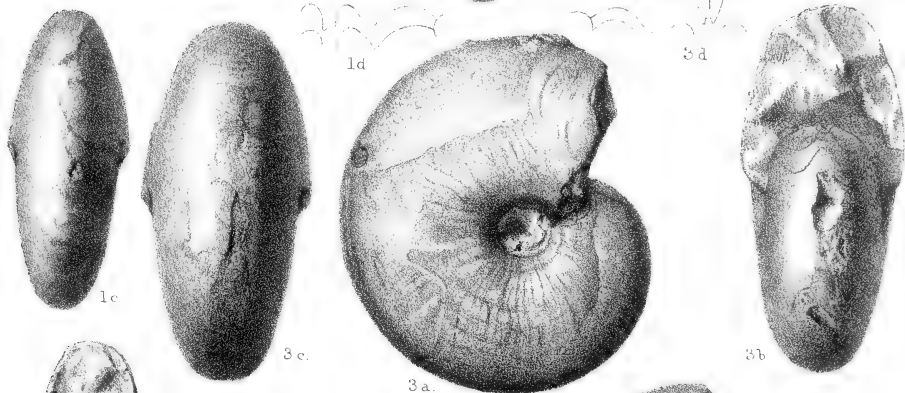
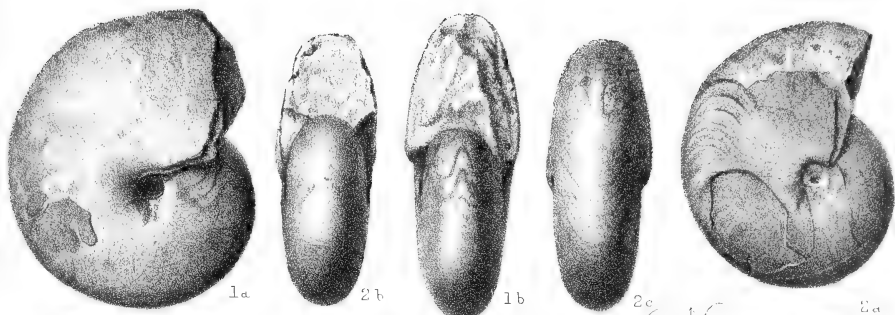


PLATE XLVI.

GLYPHIOCERAS (s.-g. BEYRICHCERAS) DIFFICILE, sp. nov.

Fig. 1 *a*. Lateral view of the much eroded and distorted type specimen, which is entirely septate. 1 *b*. Peripheral view, showing that one half of the shell has been shifted sideways across the other. 1 *c*. Suture-lines, well shown also in 1 *a*. Lisnakerry. Dublin Museum of Science and Art (Geological Survey Collection). (Page 171.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) SUBQUADRATUM, sp. nov.

Fig. 2 *a*. Lateral view of a distorted specimen. 2 *b*. Peripheral view of the same, showing truncation. 2 *c*. Suture-lines. Little Island. Mr. Joseph Wright's Collection. (Page 172.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) SPHEROIDALE? *F. McCoy*, sp.

Fig. 3 *a*. Lateral view of a somewhat distorted specimen. 3 *b*. Front view of the same. Kilmallock. Dublin Museum of Science and Art ("Griffith Collection"). (Page 173.)

Fig. 5 *a*. Lateral view of a younger undistorted individual, supposed to belong to this species, showing the ornaments of the test. 5 *b*. Front view of the same. The left-hand sigmoid line at the bottom of fig. 5 *a* is only a fracture. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection—No. 255). (Page 173.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) BROWNI? *F. McCoy*, sp.

Fig. 4 *a*. Peripheral view of a distorted specimen. 4 *b*. Lateral view of the same, showing the very large umbilicus. 4 *c*. Suture-lines, in which the peripheral lobe is not preserved. (The septate part of the specimen is filled with crystalline calcite, the deposition of which appears to have destroyed the inner whorls.) County of Limerick. Dublin Museum of Science and Art ("Griffith Collection"). (Page 175.)

PERICYCLUS LEESONI, *G. C. Crick*, sp.

Fig. 6 *a*. Front view of the type specimen. 6 *b*. Lateral view of the same. 6 *c*. Suture-line of the same, imperfect. Glenbane East. Dublin Museum of Science and Art (Geological Survey Collection). (Page 153.)



1a



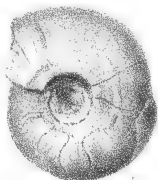
2b



2c



6a



5a



4c



2a



8b

4a



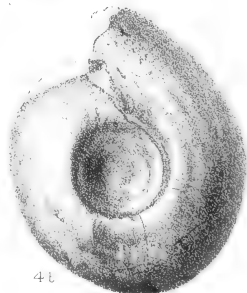
3a



4a



8c



4b



PLATE XLVII.

GLYPHIOCERAS (s.-g. BEYRICHCERAS) CORPULENTUM, *G. C. Crick*.

Fig. 1 *a*. Peripheral view of the imperfect type specimen, showing the lines of growth and the faint longitudinal bands. 1 *b*. Lateral aspect of the same; the inner whorls are not preserved. St. Doulagh's. Dublin Museum of Science and Art. (Page 176.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) CORDATUM, *G. C. Crick*.

Fig. 2 *a*. Lateral view of the imperfect and somewhat distorted type specimen, showing the very deep umbilicus, in which the inner whorls are exposed; these are well preserved in this specimen. 2 *b*. Front view, showing the sharp edge of the periphery and the cordate form of the whorl in the adult shell. 2 *c*. Suture-line. (The lateral lobe is not made sufficiently pointed in the figure.) Little Island. Dublin Museum of Science and Art. (Page 188.)

BRANCOCERAS ENNISKILLENENSE, *sp. nov.*

Fig. 3 *a*. Lateral view of an imperfect specimen with most of the test preserved. 3 *b*. Peripheral view of the same, showing the faint keel. Black Lion, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 208.)

GLYPHIOCERAS (s.-g. BEYRICHCERAS) DIADEMA, *H. E. Beyrich, sp.*

Fig. 4. Lateral view of a specimen (cast, in iron pyrites) partly embedded in the matrix. Fig. 5. Lateral view of an imperfect specimen. Fig. 6 *a*. Peripheral view of a smaller specimen. 6 *b*. Lateral view of the same. (The suture-line is well preserved in all these specimens.) Kinsale. Dublin Museum of Science and Art ("Griffith Collection"). (Page 179.)

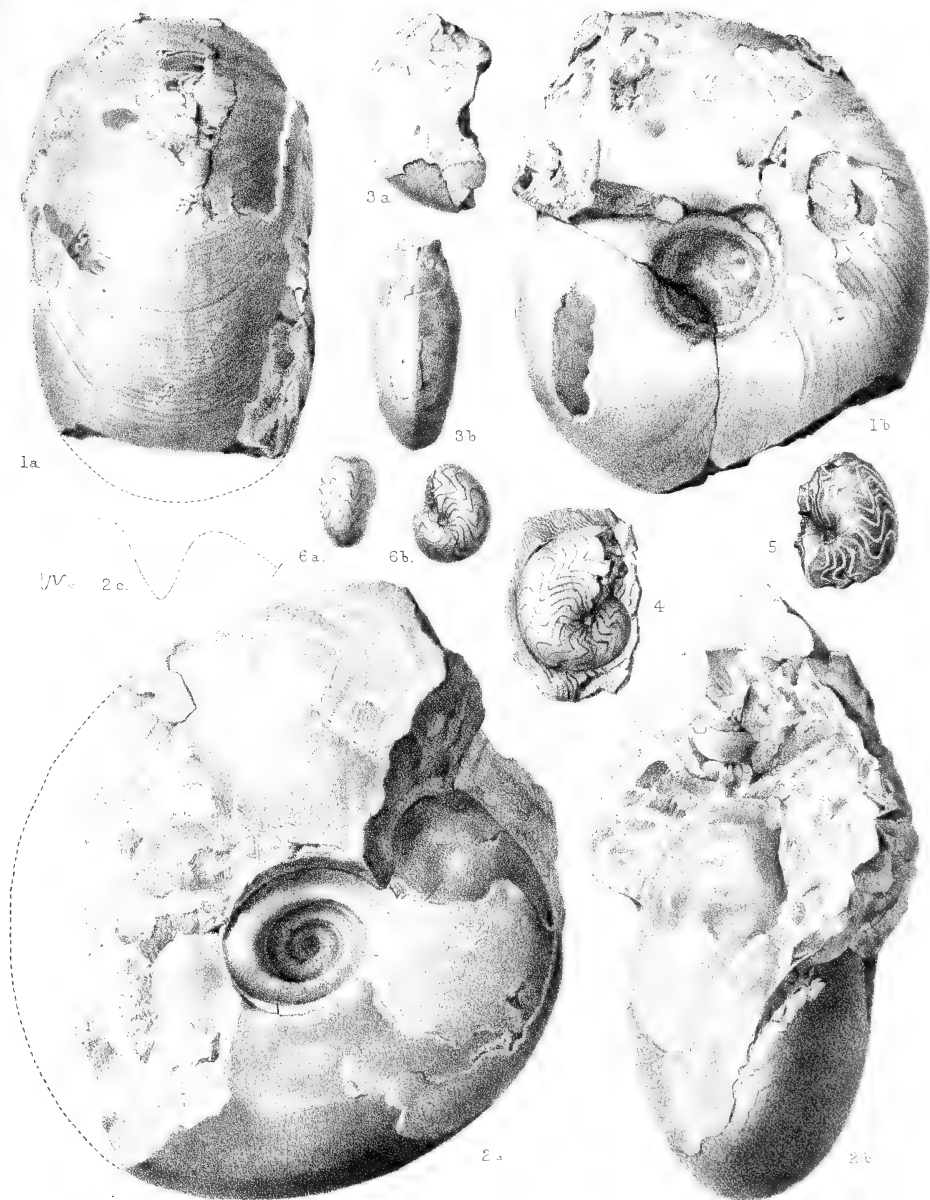




PLATE XLVIII.

GLYPHIOCERAS (s.-g. BEYRICHCERAS) CORPULENTUM, *G. C. Crick*.

Fig. 1 *a*. Lateral view of a younger specimen of this species than that figured on Pl. XLVII. 1 *b*. Front view of the same, showing the sutures upon the cast, and a portion of the test. (The lines of growth upon the test are more numerous than they are represented to be in this figure, and the lithographer has omitted to insert the faint longitudinal bands; the umbilicus is made a little too large in both figures, and in fig. 1 *b* the line representing the boundary of the umbilicus on the left-hand side of the figure has been made too low down.) 1 *c*. Suture-lines. (The lateral lobe is too obtuse and the peripheral lobe too narrow.) St. Doulagh's. Dublin Museum of Science and Art. (Page 176.)

GLYPHIOCERAS ? sp.

Fig. 2 *a*. Peripheral view of an imperfect specimen. 2 *b*. Lateral view of the same, showing the wide umbilical cavity, and a strong constriction anteriorly. Black Lion, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 209.)

Fig. 3 *a*. Front view of an imperfect specimen. 3 *b*. Lateral view of the same, showing the inner whorls and large umbilicus. Black Lion, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 210.)

PROLECANITES COMPRESSUS, *J. Sowerby*, sp.

Fig. 4 *a*. Lateral view of a large specimen elongated by distortion (reduced in this figure to about one-half of the natural size), showing some of the sutures. 4 *b*. Front view of the same. 4 *c*. Suture-line of the same (natural size; the peripheral lobe not preserved; see fig. 7). Little Island. British Museum. (Page 202.)

Fig. 5 *a*. Peripheral view of a specimen distorted similarly to 4 *a*. 5 *b*. Lateral view of the same, showing the eroded test, with faint lines of growth anteriorly. Midleton. Mr. Joseph Wright's Collection. (Page 202.)

Fig. 6. Lateral view of the specimen supposed to be the one figured by McCoy under the name of "Goniatites discus" ('Synopsis,' pl. ii, fig. 6), showing the sutures (see left-hand side of figure; the other part has been ground too deep to show them properly). Cork (city). Dublin Museum of Science and Art ("Griffith Collection"). (Page 202.)

Fig. 7. Suture-line of a specimen from Scarlet, Isle of Man, intended to be supplementary to fig. 4 *c*, as respects the peripheral lobe which is here preserved.

Fig. 8 *a*. Lateral view of an entirely septate specimen. 8 *b*. Peripheral view of the same. "Four miles east of Loughrea," county of Galway. Dublin Museum of Science and Art (Geological Survey Collection). (Page 202.)

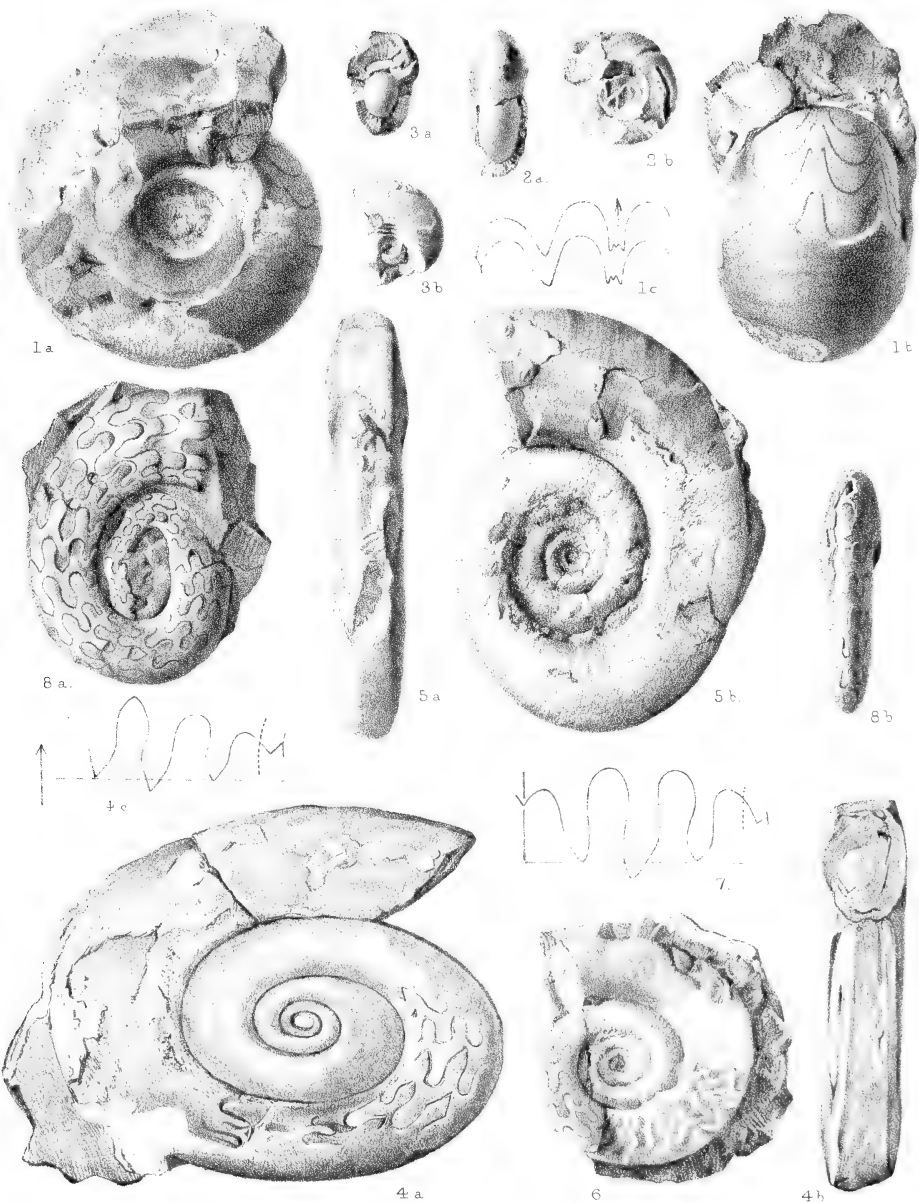




PLATE XLIX.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) BILINGUE, *J. W. Salter*, sp.

Fig. 1. Lateral view of an imperfect specimen, showing the characteristic spiral grooves and the linguiform lateral crest. Caher Lane. Dublin Museum of Science and Art (Geological Survey Collection—No. 2208 C.). (Page 186.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) RETICULATUM, *J. Phillips*, sp.

Fig. 2 *a*. Lateral view of a fragment, with some of the test adherent and a very deep and wide constriction upon the cast. 2 *b*. Enlarged view of the ornamentation, showing the fine crenulation of the lines. Rathcahill (No. —3 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 182.)

Fig. 3 *a*. Lateral view of a younger individual, showing a fragment of the test and two deep and wide constrictions upon the cast. 3 *b*. Enlarged view of the reticulate lines on the periphery. Foynes Island (No. 833 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 182.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) DAVISI ?, *A. H. Foord* and *G. C. Crick*.

Fig. 4. Lateral view of an imperfect individual doubtfully referred to this species. Rathcahill (No. 3435 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 187.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) PULCHELLUM, sp. nov.

Fig. 5. Lateral view, showing the fine ornamentation and two narrow constrictions. Rathcahill. Dublin Museum of Science and Art (Geological Survey Collection—No. 3450 C.). (Page 190.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SUBRETICULATUM, sp. nov.

Fig. 6 *a*. Lateral view of a cast, showing towards the aperture some faint traces of ornamentation in the shape of sigmoid lines; the suture-lines are well preserved. 6 *b*. Peripheral view of the same, showing the faint median keel. Foynes Island (No. 817 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 184.)

Fig. 7 *a*. Lateral view of a smaller specimen, with the test preserved. 7 *b*. Peripheral view of the same. 7 *c*. The ornamentation of the test enlarged, showing the bifurcation of the lines. 7 *d*. Suture-line of the same enlarged. Foynes Island (No. 845 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 184.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) DIADEMA ? *H. E. Beyrich*, sp.

Fig. 8 *a*. Lateral view of a young individual apparently belonging to this species, showing the strongly sigmoidal character of the ornaments of the test. 8 *b*. Front view, showing the stronger ribbing on the periphery. St. Doulagh's. Bristol Museum. (Page 179.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SPIRALE, *J. Phillips*, sp.

Fig. 9. Lateral view of a crushed cast, showing the remarkably regular spiral lines. Loughshinny. Dublin Museum of Science and Art (Geological Survey Collection). (Page 191.)

GASTRIOCERAS CIRCUMNODOSUM, sp. nov.

Fig. 10. Lateral view of an artificial cast, showing the tuberculate margin of the umbilicus and traces of ribbing on the periphery. Fig. 11. Lateral view of a younger individual. Firoda. Dublin Museum of Science and Art (Geological Survey Collection). (Page 196.)

GASTRIOCERAS CIRCUMPLICATILE, sp. nov.

Fig. 12 *a*. Lateral view, showing the plications at the edge of the umbilicus giving rise to fine transverse ribbing, and the spiral lines crossing these. 12 *b*. Peripheral view of the same, showing the median sinus indicated by the form of the ribbing. Fig. 13. Peripheral view of another individual, showing the spiral lines more distinctly than in 12 *b*. "Cliffs of Moher." Dublin Museum of Science and Art (Geological Survey Collection). (Page 200.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) TRUNCATUM, *J. Phillips*, sp.

Fig. 14. Suture-line of a large and mature specimen, giving more accurately the form of the sutures than the figure on Pl. XLIV (2 *c*). Kilmacat (county of Limerick). Museum of the Royal College of Science for Ireland. (Page 165.)

TEMNOCHEILUS CORONATUS, *M'Coy*.

Fig. 15 *a*. Lateral view of a fine specimen, showing the heavy nodes at the margin of the periphery and some of the suture-lines. 15 *b*. Front view of the same. Little Island. Mr. James Duffy's Collection (Dublin). (Page 206.)



THE
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THE
LOWER PALÆOZOIC TRILOBITES
OF THE
GIRVAN DISTRICT, AYRSHIRE.

BY
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PART I.
PAGES 1—48: PLATES I—VI.

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THE LOWER PALÆOZOIC TRILOBITES OF THE GIRVAN DISTRICT, AYRSHIRE.

INTRODUCTION.

SINCE the publication of the 'Monograph of the Girvan Silurian Fossils' by Prof. H. A. Nicholson and Mr. R. Etheridge, jun., in 1880, no detailed palæontological study of the rich trilobitic fauna of the Girvan area seems to have been made. In the meantime, however, a considerable amount of new material has been accumulated and affords scope for further work. Mrs. Robert Gray in particular has added considerably to her collection from which the majority of the specimens figured in the above-mentioned Monograph were selected; and, being desirous of having the new specimens examined in conjunction with a revision of the old material, she entrusted the task to me through the kind instrumentality of Dr. F. A. Bather, of the British Museum. The whole, therefore, of Mrs. Gray's unequalled collection has been placed in my hands at Cambridge, and the study of it has been supplemented by the examination of the trilobites from the same district in the Museum of Practical Geology, Jermyn Street; the Edinburgh Museum; the British Museum; the Hunterian Museum, Glasgow; and the Woodwardian Museum, Cambridge. Among these collections are the types of all the species described by Prof. Nicholson and Mr. Etheridge in their Monograph, besides the specimens from which the lists of species given in the Geological Survey Memoir on the Silurian Rocks of Scotland (published in 1899) were compiled.

The bibliography of the district is fully given in the last-mentioned Memoir, and need not be repeated; while the chief palæontological works on the Silurian fossils are enumerated in a list at the beginning of the Monograph by Prof. Nicholson and Mr. Etheridge.

The stratigraphical classification of the Girvan beds here adopted is that given in the recent Memoir; and it is based on that drawn up in 1882¹ by Prof.

¹ 'Quart. Journ. Geol. Soc.,' vol. xxxviii, pp. 537—666.

Lapworth, to whose labours we owe most of our knowledge of the stratigraphy. It may be summarised in tabular form as follows :

Wenlock		Blair, Knockgardner and Straiton Beds. Wenlock.
Tarannon	{ Part of Lapworth's Dailly Series	Drumyork Group. Bargany Group. Penkill Group
Llandovery	{ Newland's Series	Camregan Group } Upper Llandovery. Sauth Hill Group Middle Llandovery. Mulloch Hill Group Lower Llandovery. Drummuck Group Upper Bala.
Caradoc Formation	{ Ardmillan Series	Barren Flagstone Group. Whitehouse Group Middle Bala. Ardwell Group. Balclatchie Group
Upper Llandeilo	Barr Series	Stinchar Limestone Group } Llandeilo.

The terms employed by Mrs. Gray and some others in designating the various horizons are shown in the last column of the preceding table, and express their views of the correlation of the beds with their English or Welsh equivalents. The correlation adopted by the Geological Survey (1899), and here given in the first column, differs slightly from this, the Penkill Group being regarded as the equivalent of part of the Tarannon, while the Camregan Group alone is considered to correspond with the Upper Llandovery. The term Caradoc is used by the Survey instead of Bala, and is made to embrace the whole of the Ardmillan Series, including, at the base, the Balclatchie Group, which Mrs. Gray places as part of the Llandeilo. The Stinchar Limestone Group is termed Upper Llandeilo by the Survey.

The classification of the Trilobita here followed is that adopted by Prof. Chas. E. Beecher, of Yale University, in the translation of Prof. Karl von Zittel's 'Text-book of Palæontology' (published 1900). This seems to be the most natural and satisfactory arrangement so far proposed, and may be stated thus :

ORDER I.—*Hypoparia*.

Family 1. Agnostidæ.

2. Harpedidæ.

3. Trinucleidæ.

ORDER II.—*Opisthoparia*.

Family 1. Conocoryphidæ.

2. Olenidæ.

3. Asaphidæ.

4. Proctidæ.

5. Brontidæ.

6. Lichadidæ.

7. Acidaspidæ.

ORDER III.—*Proparia*.

- Family 1. Encrinuridae.
 2. Calymmenidae.
 3. Cheiruridae.
 4. Phacopidae.

In connection with the examination of the specimens in the various collections, my thanks are especially due to Mr. E. T. Newton, F.R.S., Dr. John Horne, F.R.S., Mr. J. G. Goodchild, and Dr. Smith Woodward, F.R.S.

SYSTEMATIC DESCRIPTIONS.

Family AGNOSTIDE.

Genus **AGNOSTUS**, Brongniart.1. **Agnostus agnostiformis** (M'Coy), 1846. Plate I, fig. 1.

1846. *Trinodus agnostiformis*, M'Coy, Syn. Silur. Foss. Ireland, pl. iv, fig. 3, p. 57.
 1848. *Agnostus convexus*, Salter, *e. p.*, Mem. Geol. Surv., vol. ii, pt. i, p. 351, pl. viii, figs. 12, 13 (non fig. 11).
 1854. *Trinodus agnostiformis*, M'Coy, Syn. Brit. Pal. Foss. Woodw. Mus., p. 141, pl. i e, fig. 10.
 — *Trinodus tardus*, M'Coy, *op. cit.*, p. 142, pl. i e, fig. 9.
 — *Agnostus trinodus*, Morris, Cat. Brit. Foss., ed. 2, p. 99.
 1864. *Agnostus trinodus*, Salter, Mem. Geol. Surv., dec. xi, pt. 1, p. 8, pl. i, figs. 8—10.
 1866. *Agnostus trinodus*, Salter, *op. cit.*, vol. iii, p. 297, pl. xix, fig. 8.
 1867. *Agnostus trinodus*, Murchison, Siluria, ed. 4, p. 204, Foss. pl. 46, fig. 6.
 1873. *Agnostus trinodus*, Salter, Cat. Camb. Sil. Foss. Woodw. Mus., p. 48.
 1877. *Agnostus trinodus*, H. Woodward, Cat. Brit. Foss. Crust., p. 22.
 1879. *Agnostus agnostiformis*, Nicholson and Etheridge, *e. p.*, Mon. Sil. Foss. Girvan, fasc. ii, p. 200 (non pl. xiv, fig. 6).

Specific Characters.—Head-shield and pygidium subequal, convex, rounded.

Head-shield forming nearly three parts of a circle or ellipse; posterior angles contracted and minutely mucronate. Narrow border of uniform width round margin, separated from limb by deep sulcus. Limb of regular width marked off from glabella by sharp continuous furrow. Glabella short, parabolic to sub-cylindrical, slightly constricted about middle, rounded at base, with pair of small transverse basal lobes.

Thorax unknown.

Pygidium semi-oval or semi-elliptical; anterior angles rectangular, not contracted. Axis shorter than glabella and subconical or parabolic, rounded; length less than basal breadth; furnished with two pairs of furrows; anterior or upper pair oblique, reaching far inwards and separating off a pair of small lobes; second

pair horizontal, rather behind middle of axis, touching in centre a prominent rounded tubercle. Limb convex, marked off from axis by strong continuous furrow. Border wider than that round head-shield, and provided with a pair of short lateral spines at about two-thirds of the distance from anterior end of pygidium.

Remarks.—The foregoing description is based on an examination of the type specimens, and supplements earlier diagnoses, which are inadequate. This typical Bala species, as defined by McCoy and Salter, has only been recognised in the Drummuck Group (Upper Bala) of the Girvan area. The examples of the genus from the Llandeilo of Balclatchie, attributed to this species, belong to a distinct form allied to *A. maccoyi*, which is described below.

Collections.—Mrs. Gray; Museum of Practical Geology, Jermyn Street.

Horizon and Localities.—Drummuck Group (U. Bala): Thraive Glen and Lady Burn (Starfish Bed).

2. *Agnostus girvanensis*, sp. nov. Plate I, figs. 2—4.

1878. *Agnostus trinodus*, Etheridge, jun., Proc. Roy. Phys. Soc. Edinburgh, vol. iv, p. 173.

1879. *Agnostus agnostiformis*, Nicholson and Etheridge, *e. p.*, Mon. Silur. Foss. Girvan, fasc. ii, p. 200, pl. xiv, fig. 6.

1899. *Agnostus agnostiformis*, *e. p.*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 514, 688.

Specific Characters.—General shape oblong, rounded.

Head-shield rounded, convex, forming about two thirds of a circle; slightly contracted at base. Glabella semi-cylindrical, gently convex, rounded at front end, about one third the width and two thirds the length of the head-shield; with two small transverse triangular lobes at its base meeting in middle line, and separated off from rest of glabella by strong oblique furrows. A transverse weak groove, curved or slightly angulated forwards, crosses the glabella rather in front of the middle, and immediately behind it is situated a small but distinct median tubercle. Axial furrows strong, subparallel, but diverging at base outside the basal lobes of glabella. Limb of uniform width, feebly convex, sloping down regularly on all sides to margin, crossed by 2—3 fine, radiating impressed lines, of which two are usually in front of the glabella. Small subtriangular area marked off on each side at posterior lateral angle by strong curved furrow. Border of head-shield narrow, rounded, ending in short spine at genal angle, and separated from limb by strong, broad marginal groove.

Thorax of two segments. Axis wide, with pair of strongly defined, oval, lateral swellings. Pleuræ very short, broad, grooved medianly, and notched so as to present bilobate tips.

Pygidium semi-elliptical or oval, rounded, convex, slightly constricted in front.

Axis broad, subconical, narrowing posteriorly to obtuse tip; about half the length of pygidium; divided into three segments, anterior one consisting of pair of small, oval, triangular lobes, not touching in middle; the second segment is marked off from the third by transverse furrow, and has a median tubercle at the posterior end of a faint central ridge; third or terminal segment shorter than second, and not invaded by median tubercle. Axis circumscribed by strong furrow. Limb as in head-shield, but narrowing anteriorly on each side owing to shape of axis. Border as in head-shield, but provided on posterior lateral margins with a pair of short, backwardly projecting spines.

Remarks.—The specimens from Balclatchie, which Nicholson and Etheridge figured (M.,¹ fasc. ii, 1879, p. 200, pl. xiv, fig. 6) as *A. agnostiformis*, are quite distinct from typical examples of that species, and belong to *A. girvanensis*. The figure given by these authors is a composite restoration drawn from three specimens—a fact noted by them on the tablet bearing the fossils, though not in the description of the plate. The figure, however, fails to give a correct idea of the characters of this form, which is more precisely diagnosed in the preceding description.

Affinities.—The transverse groove across the glabella recalls the similar feature in *A. maccoyi*, Salter;² but in the latter species there is no median tubercle, and the glabella generally expands anteriorly. The faint radiating lines across the limb also remind us of this species, but the small subtriangular areas at the base of the limb are apparently absent. The shape of the glabella and the absence of a transverse groove and median tubercle distinguish *A. agnostiformis* from our Girvan form.

The description of the thorax which is here given is based on one individual having one thoracic ring nearly completely preserved. The short broad pleuræ, grooved and notched at the ends, recall *A. princeps*, Salter, but the axis with its lateral nodules seems more like *A. tardus*, Barr.

The pygidium has an axis relatively rather longer and narrower than *A. agnostiformis*; the median tubercle forms the swollen posterior extremity of a longitudinal low ridge, and herein also differs from the latter species; but in the segmentation of the axis it agrees. The posterior segment in the typical examples of *A. maccoyi* is much longer. There is also a pair of short lateral spines on the border, which is broad and rounded and separated from the limb by a broad sulcus, as in *A. agnostiformis*. There is thus seen to be a combination of the characters of *A. maccoyi* and *A. agnostiformis*, with some others not found in either. But, on the whole, the affinity seems closer with the former than with the latter.

In *A. glabratus*, var. *ingrica*, Schmidt,³ there is on the axis of the pygidium a

¹ The letter "M" is used to signify the 'Monograph of the Silurian Fossils of the Girvan District.'

² Salter, 'Mem. Geol. Surv.,' dec. xi (1864), pl. i, fig. 6.

³ Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. iv, p. 90, pl. vi, figs. 39—43.

similar elongated central tubercle or ridge traversing the two front rings; and the glabella also possesses a faint transverse furrow. The same features are noticeable in *A. sidenbladhi*, Linnar.,¹ while in *A. caducus*, Barr.,² there is also a small tubercle behind the transverse furrow on the glabella.

Collections.—Mrs. Gray (f. M.)³; Edinburgh Museum; Museum of Practical Geology, Jermyn Street; Woodwardian Museum, Cambridge; Hunterian Museum, Glasgow.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Ardmillan; Dow Hill; Penwhapple Burn.

3. *Agnostus perrugatus*, Barrande, 1872. Plate I, figs. 5—7.

1872. *Agnostus perrugatus*, Barraude, Syst. Silur. Bohême, I suppl., p. 143, pl. xiv, figs. 14—16.

1880. *Agnostus perrugatus*?, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. iii, p. 296, pl. xx, figs. 6, 7.

1899. *Agnostus perrugatus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 517, 672, 688.

Specific Characters.—Head-shield subquadrate, longer than broad, narrowing slightly near base, feebly convex, with narrow concentric rounded border. Glabella subcylindrical, but expanding at base, more than half the length and about one third the width of the head-shield. Two oblique furrows cut off large triangular basal lobes. Two transverse furrows angulated forwards in the middle mark off a narrow transverse lobe behind the frontal lobe of the glabella. Frontal lobe about one third the total length of glabella; middle lobe shorter; posterior lobe the longest of all three. Axial furrows distinct, run convergently forward to middle of glabella, then almost parallel to front end, round which they curve and unite. Limb of head-shield marked on each side of glabella by 6—7 low rounded radiating ridges, which bifurcate once or twice near border. In front of glabella are two adjacent longitudinal similar ridges, which do not bifurcate but narrow anteriorly.

Pygidium of similar shape to head-shield, with narrow concentric rounded border, widening a little posteriorly and furnished with a pair of short lateral spines at posterior angles. Axis short, subconical, with rounded extremity; about half the length of pygidium; divided into three segments by transverse furrows. Posterior segment the largest; the other two subequal, and interrupted down

¹ Linnarsson, 'Vestergötl. Camb. Silur. Aflagr.,' 1869, p. 82, pl. ii, figs. 60, 61. Brögger, 'Die Silur. Etagen II and III,' 1882, p. 56.

² Barraude, 'Syst. Silur. Bohême,' I suppl., p. 142, pl. xiv, figs. 12, 13. Novák, 'Beitr. Palæont. Cesterr.-Ung.,' iii, (2) 'Zur Kennt. böhm. Trilob.,' p. 56, pl. x, figs. 20—23.

³ The letters "f. M." in brackets after the name of any collection signify that the specimen or specimens figured by Prof. Nicholson and Mr. Etheridge in their 'Monograph of the Silurian Fossils of the Girvan District' are in that collection.

the middle by narrow longitudinal ridge dying out on posterior segment. Limb ornamented by radiating bifurcating ridges similar to head-shield, but no distinct parallel simple pair behind axis.

Remarks.—There was some doubt in the minds of Professor Nicholson and Mr. Etheridge whether the Girvan specimens really belonged to Barrande's species, *A. perrugatus*, but a minute examination of a series of specimens, including the types, from Whitehouse Bay removes any hesitation in definitely referring them to the Bohemian species.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology, Jermyn Street; Edinburgh Museum.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

4. **Agnostus tardus**, Barrande, 1846. Plate I, figs. 8, 9.

1846. *Battus tardus*, Barrande, Not. prélim., p. 35.

1847. *Arthrorhachis tarda*, Corla, Prodr. Böhm. Trilob., p. 115, pl. vi, fig. 60.

1852. *Agnostus tardus*, Barrande, Syst. Silur. Bohême, vol. i, p. 913, pl. xlix.

Specific Characters.—Body strongly swollen transversely; shape oblong, rounded.

Head-shield semi-oval (there is a long form and a short form). Glabella semi-cylindrical to semi-oval, one fourth the width and rather less than one half the length of the head, regularly convex, without lobes. Axial furrows strong, and in them at base of glabella on each side is a small tubercle. Limb (genal zone) of regular width. Border a little wider in front than behind, with well-marked marginal groove and small genal spines at posterior lateral angles.

Thorax of two segments; axis wide, two thirds the breadth of thorax, showing median and two lateral nodules. Pleuræ very short and grooved.

Pygidium with semi-oval axis a little less than half the width and half the length of pygidium, and showing traces of three segments; anterior segment like thoracic segment, with three nodules and marked by two small longitudinal furrows; posterior segment rudimentary. Border simple, well developed, like that round head-shield, without lateral spines. Surface of body smooth.

Remarks.—The above description is that of Barrande, based on the Bohemian specimens. Only one example of the head-shield and one of the pygidium of this species from the Girvan district have so far come under my notice. Both are from Whitehouse Bay, and show the characteristic features of the species.

Affinities.—This species is so similar to *A. agnostiformis* that it requires a very close examination to detect the differences, particularly in imperfectly preserved examples. As Salter remarked (Mem. Geol. Surv., dec. xi, 1864, art. 1, p. 9), *A. tardus* has no trace of the slight lateral indentations on the sides of the glabella,

and the marginal spines on the pygidium are absent. It may also be added that the posterior angles of the head-shield are not contracted, giving a different outline to the head, and that the central tubercle on the second axial segment of the pygidium is in the form of an elongated ridge extending from the front border to the second transverse furrow. In *A. agnostiformis* this axial tubercle is isolated, and is placed across the second transverse furrow, which is thus interrupted by it.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

Family HARPIDIDÆ.

Genus **HARPES**, Goldfuss.

1. **Harpes flanaganii**, Portlock, 1843. Plate II, figs. 12, 12 *a*.

1843. *Harpes flanaganii*, Portlock, Geol. Rep. Londond., p. 268, pl. v, figs. 5 *a*, 5 *b*, 6, 7.

1854. *Harpes flanaganii*, Morris, Cat. Brit. Foss., ed. 2, p. 109.

1872. *Harpes flanaganii*, Murchison, Siluria, ed. 5, p. 206, Foss., pl. 48, fig. 4.

1877. *Harpes flanaganii*, H. Woodward, Cat. Brit. Foss. Crust., p. 37.

1899. *Harpes flanaganii*, Reed, Quart. Journ. Geol. Soc., vol. lv, p. 745.

Remarks.—There are two complete “horseshoe” limbs and some fragments of this species of *Harpes* from Ardmillan which have come under my notice; the larger one measures 21 mm. in length, and is in Mrs. Gray’s collection; the smaller one measures about 13 mm. in length, and is in the Museum of Practical Geology. Another perfect example of about the same size as the latter comes from Balclatchie, and a fragment of a limb from Craighead may also belong to the same species. There is also a portion of a limb and cheek from Dow Hill.

The “horseshoe” is subquadrate in form, being nearly as wide as long and somewhat flattened in front; the inner margins of the arms are nearly parallel, but the ends, which are acutely pointed, bend slightly inwards. The limb itself is slightly excavated on the upper side, but is horizontally extended, and is closely covered with small circular pits, not arranged in any definite order. Inside the narrow smooth raised outer border is a single row of larger pits, and this row exists round the whole free arms of the limb. The cheek (as seen in the fragment from Dow Hill) is strongly convex and rises steeply from the limb, from which it is separated by a narrow smooth band, bordered on both sides by a single irregular row of pits of larger size than those covering the limb. The cheek, which bears on its summit a small prominent stalked eye, is marked by rows of minute pits closely set in regular radiating lines, but the posterior lateral angle of the cheek has on its basal slopes pits like those on the limb. The shape of the “horseshoe” and

characters of the limb resemble *H. flanaganii*, Portlock, but the ornamentation of the cheeks recalls *H. wegelini*, Angelin.

Collections.—Mrs. Gray; Museum of Practical Geology, Jermyn Street.

Horizons and Localities.—Balclatchie Group (Llandeilo): Ardmillan; Dow Hill; Balclatchie. ? Stinchar Limestone Group (Llandeilo): Craighead.

2. **Harpes**, sp. ind. (*a*). Plate II, fig. 13.

Remarks.—A fragment of the limb of a species of *Harpes* was obtained from Shalloch Mill. It has a flattened surface covered with small deep irregularly distributed pits, not closely set. On the inner side of the raised rounded border is a single regular row of much larger equidistant pits. The border appears to be transversely striated.

This form differs from that found at Ardmillan and Balclatchie by the wider border and smaller, less closely set pits.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill.

3. **Harpes**, sp. ind. (*b*). Plate II, fig. 14.

Remarks.—There is one nearly complete horseshoe-shaped limb from Bargany Pond Burn in Mrs. Gray's collection, but I have not seen any other portion of a *Harpes* from the Silurian beds of Girvan. This specimen has a length of about 21 mm. and a width of about 18 mm.; the breadth of the limb is almost constant and is about 4 mm. The shape is subquadrate, being rather flattened in front and the arms nearly parallel, but the free ends bend inwards towards each other, decrease in width posteriorly, and are acutely pointed. The surface of the limb is flattened and covered with very minute punctations, apparently not arranged in any definite order. There is a narrow raised border round the outer edge of the limb, but no row of larger pits inside it. The cheeks, which rise steeply from the limb and are separated from it by a smooth groove bordered by a row of larger pits on each side, are only imperfectly preserved. They show fine radiating grooves, containing very minute pits, on their surface. The portion of the cheeks immediately adjoining the limb forms a distinct gently convex band, specially swollen in front of the glabella and distinctly marked off from the upper part of the cheeks. *Harpes vittatus*, Barrande ('Syst. Silur. Bohême,' vol. i, p. 349, pl. ix, figs. 7—10), from Ét. E., resembles it closely in this feature as well as in the shape of the limb, curvature of the arms, punctuation, and narrow raised border.

Collection.—Mrs. Gray.

Horizon and Locality.—Camregan Group (U. Llandoverly): Bargany Pond Burn.

4. **Harpes**, sp. ind. (c).

Remarks.—An imperfect limb from Aldons differs from the other Girvan examples of the genus by the narrowness of the limb and its general shape. It is strongly arched, and the ends bend inwards to a considerable extent, the arms not being parallel. The limb is only 3 mm. broad, which is less than one-sixth the width of the whole horseshoe. The lower surface has the shell preserved, and scarcely shows any punctations, but a single row of larger pits lies inside the rounded border, as in *H. flanaganii*. *H. parvulus*, McCoy ('Contrib. Palæont.,' 1854, p. 209, and 'Syn. Brit. Pal. Foss.,' p. 336, pl. II, fig. 3), from the same horizon, has a wider limb, but the type is too badly preserved for a thorough comparison.

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchur Limestone Group (Llandeilo): Aldons.

Family TRINUCLEIDÆ.

Genus **TRINUCLEUS**, Llwyd.

1. **Trinucleus bucklandi**, Barrande, 1846. Plate I, figs. 10—14.

1846. *Trinucleus bucklandi*, Barrande, Not. Prélim., p. 31.

1847. *Trinucleus bucklandi*, Corda, Prod. Mon. Böhm. Trilob., p. 39.

1852. *Trinucleus bucklandi*, Barrande, Syst. Silur. Bohême, vol. i, p. 621, pl. xxix, figs. 10—17.

1876. *Trinucleus bucklandi*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.

? — *Trinucleus seticornis*, Armstrong and Young, *ibid.*, p. 16.

1879. *Trinucleus seticornis* (Hisinger) var. *bucklandi*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 190, pl. xiii, figs. 13—20.

1899. *Trinucleus bucklandi* and *T. seticornis*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, p. 524.

Remarks.—This is an exceedingly common trilobite at Drummuck, and is largely represented in most collections from this locality and also from Thraive Glen and Lady Burn. It is this species which Nicholson and Etheridge named *T. seticornis*, Hiss., var. *bucklandi*, Barr. (M., fasc. II, 1879, p. 190, pl. xiii, figs. 13, 14 (?), 15, 16, 17 (?), 18—20), and they gave a careful and excellent description of the Girvan form which only requires the addition of a few minor details. It is stated by them that the surface of the glabella is reticulate, and they give a figure (M., *loc. cit.*, pl. xiii, fig. 17) which shows a coarse reticulate ornamentation. From the minute examination of a very extensive series of specimens, many retaining the shell and in excellent preservation, there can be no doubt that the surface of the glabella as

well as of the cheeks in the adult is smooth, as Barrande states. From internal casts of adults there is also no evidence that the inner surface of the shell was always reticulate. The outer surface of the smaller and presumably immature specimens is also smooth, but the inner surface in some of these young individuals is minutely pitted or reticulate, and it is probable that the ornamentation like the "ocular" tubercle disappears with age. Barrande notices a reticulation in some specimens, but it is not taken by him as characteristic of the species.

The variations in the development of the fringe which are due to age are correctly noticed by Nicholson and Etheridge, but it may be added that the older individuals have the outermost row of pits larger and more elongated than the others, and in some cases these contain not only two but even three pores in a line. With regard to the pygidium, the first six transverse furrows across the axis have a deep pit on each side in the axial furrows, as partly indicated in one figure (M., pl. xiii, f. 13) but not mentioned in the text.

The identity of the Girvan form with the Bohemian *T. bucklandi* seems to be beyond doubt, as a comparison with some of Barrande's specimens shows; but with respect to *T. bucklandi* being a variety of *T. seticornis*, His., I am not at all satisfied with the evidence or arguments of Nicholson and Etheridge. Nor do I consider it sufficiently demonstrated that the adult form of *T. seticornis* is equivalent to the young or middle-age stages of the Bohemian *T. bucklandi*. It appears to me better for the present to keep the Girvan form apart from that known as *T. seticornis*, especially as there still exists some confusion in the interpretation of the latter species in the British Isles.

The Girvan examples of *T. bucklandi* reach an unusually large size for individuals of *Trinucleus*, some of the head-shields measuring nearly 20 mm. in length without reckoning the genal prolongations of the fringe.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum; Museum of Practical Geology, Jermyn Street; British Museum; Woodwardian Museum; Hunterian Museum, Glasgow.

Horizons and Localities.—Drummuck Group (U. Bala): Drummuck and Thraive Glen; Starfish Bed, Lady Burn.

2. *Trinucleus* ? *macconochiei*, Etheridge and Nicholson, 1879.

1879. *Ampyx* ? *macconochiei*, Etheridge and Nicholson, Mon. Sil. Foss. Girvan, fasc. ii, p. 183, pl. xiv, fig. 1.

1880. *Trinucleus macconochiei*, Etheridge and Nicholson, Mon. Sil. Foss. Girvan, fasc. iii, p. 288, pl. xix, fig. 9.

1899. *Trinucleus macconochiei*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 674, 689.

Specific Characters.—General form broadly oval.

Head-shield transverse, semicircular. Glabella and cheeks convex and ornamented with minute punctæ arranged in concentric and slightly inosculating lines. Glabella pyriform, projecting in front of cheeks, constricted at base, with a pair of pit-like furrows. No fringe preserved. Axial furrows deep, strong. Cheeks triangular, swollen.

Thorax of five segments; axis convex, very narrow, cylindrical, about one fifth of whole width of thorax; pleuræ horizontal, straight, deeply grooved along their length.

Pygidium small, broadly semicircular, more than twice as wide as long, with broad bevelled edge concentrically lineate; axis of 4—5 rings, gradually tapering, convex, very narrow; lateral lobes with three pairs of strong raised radiating pleuræ, and a fourth pair less distinct. Surface of thorax and pygidium more coarsely punctate than head-shield.

Dimensions.—

Length of head	.	.	.	.	3·0 mm.
Length of thorax	.	.	.	.	2·5 „
Width of thorax	.	.	.	.	5·0 „
Length of pygidium	.	.	.	.	1·5 „
Width of pygidium	.	.	.	.	4·5 „

Remarks.—In default of any better specimen than the type figured by Nicholson and Etheridge (*op. cit.*) this species must still remain imperfectly known. After an examination of the type and of two other examples I am unable to find much to add or to modify in the original description summarised above.

In the absence of any trace of the characteristic fringe of *Trinucleus* and in the number of thoracic segments I have still some doubt as to the genus to which this form should be referred.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum; Museum of Practical Geology, Jermyn Street.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

3. *Trinucleus subradiatus*, sp. nov. Plate II, figs. 1—6.

Specific Characters.—Head-shield transverse, rounded, slightly subquadrate in outline, and broadest in front of genal angles; about three times as wide as long; lateral border meets posterior border at about 80°. Genal angles furnished with short spines projecting slightly outwards, and not in line with the lateral border. Fringe rather narrow in front of glabella, but increasing rapidly to double the width at genal angles; slightly bent down in front but less so laterally, with flattened almost horizontal narrow marginal portion bearing two regular concentric rows of pits of equal size but not in any regular radiating or alternate order, laterally reinforced by a more or less distinct third inner concentric but

less regular row. Inside these marginal rows and on the more steeply inclined inner portion of the fringe are many more or less concentric rows of radially arranged pits of much smaller size. Towards the posterior margin of the head-shield these inner radial rows lose to some extent their regularity, and have inserted between them and the marginal rows many irregularly placed pits of intermediate size, occasionally with an obscure radial or linear arrangement. The genal angles of the fringe are slightly extended behind the posterior margin of the head-shield. Glabella pyriform, strongly elevated near the anterior end and swollen, laterally compressed and posteriorly sharply carinated; possesses no distinct neck, but two pairs of short broad furrows indent the sides, and two pairs of deep pits lie at the base of it in the axial furrows. The glabella rises steeply from the inner side of the fringe and does not overhang or invade it. Occipital furrow strong. Occipital ring broad in centre and produced backwards into short triangular nuchal spine. Cheeks sharply marked off from fringe, slightly swollen, much less elevated than glabella, as broad as long; bear median ocular tubercle connected with glabella by fine oblique ocular ridge.

Axial furrows well marked, with a pair of pits in their course near front end of glabella. Glabella and cheeks ornamented with closely set minute pits.

Thorax too imperfect for description, but apparently showing the usual generic characters.

Pygidium unknown.

Dimensions.—

Length of head-shield	.	.	.	7—8 mm.
Width of „	.	.	.	15—16 „

Affinities.—In outline the head-shield resembles *T. fuvus*, Salter ('Mem. Geol. Surv.,' vol. ii, pt. 1, 1848, pl. ix, fig. 3). The carinated glabella recalls *T. Lloyd*, Murchison ('Silur. Syst.,' 1839, pl. xxiii, fig. 4), and so do the nuchal spine and the radiating rows of pits on the fringe, but the Girvan form differs by the strong differentiation in the size of the marginal and inner pits of the fringe, the more numerous inner rows, the non-concave fringe, the lateral furrows of the glabella, and the shape of the head-shield. *T. radiatus*, Murchison (*op. cit.*, pl. xxiii, fig. 3), bears a somewhat strong resemblance, but has the pits on the fringe lying in furrows with a more distinct radial arrangement. *T. concentricus*, Eaton, resembles it in the pear-like shape of the glabella and in the neck-spine, but the fringe is completely different. The peculiar elevation and carination of the glabella are found also in *T. reticulatus*, Ruedemann ('New York State Mus. Bull.,' No. 49, 1901, p. 41, pl. iii, figs. 15, 16, 18, 19), but this species has no neck-spine and an entirely different fringe. It was from the erroneous identification of some of these specimens that the species *Tr. ornatus* and *Tr. concentricus* seem to have been recorded by the Geol. Survey as Girvan forms ('Mem. Geol. Surv., Silur. Rocks Brit.,' vol. i, Scotland, pp. 671—689).

Collections.—Mrs. Gray; Museum of Practical Geology, Jermyn Street; Edinburgh Museum; Woodwardian Museum.

Horizon and Locality.—Balclatchie Group (Llandeilo): Dow Hill; Balclatchie Conglomerate.

4. **Trinucleus**, sp. ind. (*a*). Plate II, figs. 7, 7 *a*, 7 *b*.

1879. *Trinucleus*, sp. ind. *a*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 198, pl. xiv, fig. 2.

Specific Characters.—Head-shield semicircular; fringe flattened, slightly bent down, widest at genal angle. Genal angle provided with strong spine of moderate length, projecting outwards, slightly curved backwards and longitudinally grooved on upper surface. Fringe possesses two outer regular rows of radially arranged pits, becoming confluent near genal angles. Inside these two rows are 2—4 regular rows of more or less radially arranged pits of equal size in front of the cheeks and glabella, but becoming irregular in arrangement and more numerous near genal angles. Fringe increases in width towards genal angles, but is scarcely at all produced backwards. A narrow raised angular border surrounds it. Glabella possesses ovoid swollen frontal lobe, not overhanging fringe; posterior portion unknown. Cheeks triangular, gently convex, sloping gradually down to fringe. Ocular tubercle present. Surface of glabella and cheeks coarsely reticulate.

Remarks.—The fragment of the genal angle and fringe of a species of *Trinucleus* described by Nicholson and Etheridge as 'sp. ind. *a*' corresponds with the fringe attached to several fragmentary head-shields from the same locality in Mrs. Gray's collection. The above somewhat fuller description of the form is therefore now possible, though not sufficient for its specific determination.

Affinities.—This form is scarcely sufficiently preserved to determine its affinities, but it seems more to resemble *T. concentricus* than *T. bucklandi*.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian Museum.

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill.

5. **Trinucleus**, sp. ind. (*b*). Plate II, figs. 8, 8 *a*.

1879. *Trinucleus*, sp. ind. *b*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 198, pl. xiv, fig. 3.

Remarks.—The specimen which Nicholson and Etheridge figured consists of only one cheek and a portion of the fringe. There are, however, some better specimens of the whole head-shield in Mrs. Gray's collection. It is probable that

they are all immature individuals, as the primitive state of the fringe seems to suggest a pre-adult stage. The pits of the fringe are radially arranged in two concentric rows, and in front of the glabella are more or less radially fused. The glabella consists of an anterior swollen ovoid portion sharply marked off behind from a depressed simple cylindrical neck. No lateral furrows notch it, but at the base of the swollen anterior portion two small tubercles are in one specimen noticeable in the axial furrows. The surface of the glabella and cheeks is smooth. With regard to affinities, the species *T. waldenbergi*, Rouault, appears to have a glabella with similar characters (see Rouault, 'Bull. Soc. Géol. France,' ser. ii, vol. vi [1848], p. 86; Angelin, 'Pal. Scand.' [1854], p. 64, pl. xxxiv, fig. 1; Linnarsson, 'Vestergötl. Camb. Sil. Aflagr.,' 1869, p. 76).

Collection.—Mrs. Gray (f. M.).

Horizon and Localities.—Whitehouse Group (M. Bala): Shalloch Mill (f. M.) and Whitehouse Bay.

6. *Trinucleus*, sp. ind. (*c*). Plate II, fig. 9.

1879. *Trinucleus*, sp. ind. *c*., Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 198, pl. xiv, fig. 4.

Specific Characters.—Pygidium broadly triangular; length 7 mm., breadth 18.5 mm. Axis gently convex, conical, gently tapering; reaches posterior border; consists of about 14—15 rings, of which only the first seven or eight are distinct. Behind the first three rings the axis is faintly trilobed. Lateral lobes flattened, horizontally extended, with four well-defined straight pleuræ followed by several indistinct ones. The three anterior pleuræ have a narrow band on their front edge and correspond with the three first axial rings. Border consisting of narrow raised rim and broad bevelled portion.

Remarks.—Certain features not mentioned by Nicholson and Etheridge render the above fuller description of this well-defined and well-preserved pygidium desirable, particularly as the original figure is inaccurate. It probably belongs to one of the foregoing species.

Collection.—Mrs. Gray (f. M.).

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill.

7. *Trinucleus*, sp. ind. (*d*). Plate II, figs. 10, 10*a*.

Specific Characters.—Head-shield semicircular; glabella just reaching fringe but not invading it, composed of large swollen ovoid anterior portion with median tubercle, and of a very short well-defined neck. Cheeks convex, separated from glabella by deep axial furrows. Neck-segment very narrow. Fringe narrow,

sharply marked off from cheeks, composed of 3—4 concentric rows of small pits in front and 4—5 laterally. Genal angles not produced backward but armed with very short broad spines.

Pygidium broadly subtriangular with wide bevelled striated border; conical axis about one fourth the width of pygidium, possessing 5—7 rings with a pair of pits in the furrows between them. Lateral lobes flat with 2—3 indistinct pleuræ.

Dimensions.—

	Length.	Width.
(1) Head	4·5 mm.	6·0 mm.
(2) Pygidium	3·0 mm.	8·0 mm.

Remarks.—Some small head-shields and pygidia from the Bala beds of Whitehouse Bay in Mrs. Gray's collection, apparently belonging to the same species, possess the above characters, and seem to mark a distinct species, but the material is too imperfect and scanty for a more detailed diagnosis.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

8. *Trinucleus*, sp. ind. (*e*).

1880. *Trinucleus*, sp. ind., Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. iii, p. 288, pl. xix, fig. 10.

Remarks.—The crushed specimen of a head-shield, figured by Nicholson and Etheridge as '*Trinucleus*, sp. ind.,' is in a very poor state of preservation, but the broad fringe with its backwardly produced genal angle appears to have some of the characters of *Tr. bucklandi*. The surface of the glabella and cheeks is reticulate, but not so coarsely as in *Trinucleus*, sp. ind. *d*, and there is a median tubercle on the glabella not mentioned by Nicholson and Etheridge. It is impossible to define this form more precisely on account of its very imperfect condition, and I much doubt if it is really a distinct species.

Collection.—Mrs. Gray (f. M.)

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

9. *Trinucleus*, sp. ind. (*f*). Plate II, fig. 11.

Specific Characters.—Pygidium broad, short, rounded, not triangular, about three times as wide as long. Axis broad, rounded, slowly tapering, occupying nearly the middle third of pygidium; composed of 5—6 rings of which the first 3—4 are complete. Lateral lobes flat with 2—3 obscure pleuræ.

Dimensions.—

Length	.	.	.	3 mm.
Width	.	.	.	9 „

Remarks.—This small pygidium from Shalloch Mill may possibly belong to one of the foregoing forms; but as it has not been found in definite association with any of them, it is preferable to describe it separately.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill; Whitehouse Bay.

10. *Trinucleus*, sp. ind. (*g*).

Remarks.—Two small fragments of a head-shield are the only evidence which I have seen of the occurrence of the genus *Trinucleus* at Craighead. One of them shows a portion of the anterior swollen part of the glabella invading the fringe so as to leave only one row of pits in front of it. The fringe, which is slightly bent down, has at the sides two regular outer concentric rows of pits, radially arranged and of equal size, and an inner third row of irregular rather smaller alternating pits, while towards the base two more inner irregular rows are inserted. There is a bevelled and grooved border surrounding the fringe. The surface of the cheeks and glabella appears to be smooth. Except that these fragments are the only portions of *Trinucleus* from Craighead they would not be worthy of description.

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchur Limestone Group (Llandeilo): Craighead.

Genus **AMPYX**, Dalman.

1. *Ampyx depressus* (Angelin), 1854. Plate III, figs. 6, 7.

1854. *Raphiophorus depressus*, Angelin, Pal. Scand., p. 82, pl. xl, fig. 9.

Remarks.—Two minute head-shields, about 3 mm. long, represent this species in Mrs. Gray's collection. They are sufficiently well preserved to show all the features indicated by Angelin in his *Raphiophorus depressus*. The broadly ovoid glabella, truncated posteriorly and furnished in front with a slender tapering grooved spine, rather longer than the glabella; the faint pair of nodules at the base of the glabella, and the gently convex cheeks, almost equilateral triangles in shape, are all clearly exhibited in these Girvan specimens.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

2. *Ampyx drummuckensis*, sp. nov. Plate III, figs. 1—5.

? 1876. *Ampyx rostratus*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.

1879. *Ampyx rostratus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 178, pl. xii, figs. 14, 15; pl. xiii, figs. 1—3.

Specific Characters.—Head-shield triangular, acutely pointed in front, a little longer than wide. Glabella long, diamond-shaped, expanding to middle, then contracting to apex; greatest width across middle and equal to about half the length; convex with greatest elevation at middle, thence tapering anteriorly; a low keel more or less obsolete runs along whole length of glabella, but bifurcates near front end into narrow ridges enclosing groove which is continued along spine; front end of glabella conical, rounded, freely projecting in front of cheeks, and furnished with long straight horizontal spine two to three times the length of the glabella and marked with a broad shallow groove along its whole length. Base of glabella truncated, not pointed, and about half the width of broadest part. Near the base is a pair of transverse deep isolated pits or short grooves (seen only in some specimens) a little in front of the occipital furrow, which is faint and separates off a feebly rounded projecting occipital segment. Axial furrows shallow but distinct, nearly straight, diverge anteriorly at about 30° , dying out almost completely (except in casts) a little behind the middle of the glabella. At this point a pair of oblique deep pits (only visible in casts) occurs on each side of the glabella.

Fixed cheeks triangular, weakly convex, gently bent down, extend halfway up glabella to broadest part, where they slope downwards rapidly. Neck segment distinct, marked off by strong straight furrow. Facial suture weakly sigmoidal, and its general course at about 75° to posterior margin. Fixed cheek at base measures about one and a half times basal width of glabella.

Free cheeks narrow, marginal, with genal angles furnished with long curved flattened and grooved spines, at least half as long again as the head-shield. Surface of shell coarsely punctate (seen also in casts).

Thorax (imperfectly known) of five segments, short, broad, not as long as head-shield. Axis convex, wider than pleuræ, cylindrical. Pleuræ horizontal, straight, flattened, grooved along their length.

Pygidium triangular, more than twice as wide as long with broad bevelled concentrically striated border. Axis conical, pointed, reaching bevelled border behind, less than one-third the width of pygidium, gently convex, segmented along whole length, furnished with 7—9 pairs of tubercles arranged in a row on each side of axis and connected by narrow transverse furrows, thus indicating the segments. One strong simple complete ring marked off at front end of axis. Axial furrows strong. Lateral lobes weakly convex, smooth, with only one strong oblique furrow near front edge. Surface of shell of pygidium coarsely punctate.

Dimensions.—

	I.	II.
Width of middle-shield at base . . .	21·0 mm.	16·0 mm.
Length of head to base of spine (about) . . .	18·0 „	15·0 „
Width of glabella at base . . .	5·0 „	4·0 „
„ „ across middle . . .	10·0 „	8·5 „

Remarks.—The species *Ampyx rostratus*, Sars, has been recorded on several occasions and from several localities in the British Isles, but Schmidt ('Rev. Ostbalt. Silur. Trilob.,' pt. iv, 1894, p. 85) has some justification in doubting whether Sars' species really occurs in Britain. Certainly the Girvan specimens from the Drummuck beds which have been attributed to it show some important points of difference, and their characters appear to indicate a new species which may be termed *A. drummuckensis*. Nicholson and Etheridge's diagnosis of *A. rostratus* is based on these Girvan specimens, which show some minor points of difference amongst themselves, but these are found by the examination of further material to be largely due to their state of preservation. The above is an amended description of this new species.

Affinities.—The punctate surface at once serves to distinguish this species from *A. rostratus*, Sars, which is smooth (Pompecki, 'Trilob. Ost.-westpreuss. Diluv.-geschieb.,' 1890, p. 16). But there are also other points of difference, such as the two pairs of pits in the front part of the axial furrows, the pair of transverse grooves near the base of the glabella, the weakly sigmoidal, less oblique facial sutures, the smooth lateral lobes of the pygidium, etc. There can, however, be no doubt that this Girvan species is closely allied to *A. rostratus*. An interesting enrolled specimen of a nearly perfect individual from the Starfish Bed is in Mrs. Gray's collection and is here figured (Pl. III, fig. 5).

Collections.—Mrs. Gray (f. M., pl. xiii, figs. 1—3); Museum of Practical Geology (f. M., pl. xii, figs. 14, 15); Edinburgh Museum.

Horizon and Localities.—Drummuck Group (U. Bala): Drummuck; Thraive Glen. Starfish Bed: Thraive Glen.

3. *Ampyx hornei*, Nicholson and Etheridge, 1879. Plate III, figs. 8—10.

‡ 1876. *Ampyx mammillatus*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.

1879. *Ampyx hornei*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 184, pl. xiii, figs. 4—8.

‡ 1879. *Asaphus*, sp., Nicholson and Etheridge, *ibid.*, p. 154, pl. x, fig. 20.

1899. *Ampyx hornei*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 672, 688.

Specific Characters.—Head-shield broadly semicircular, more than twice as broad

as long, curvature rather flattened anteriorly; posterior margin concave owing to slight bending back of lateral angles of middle-shield. Glabella oval, about one third the width of head-shield, with subpyriform swollen anterior half and depressed posterior portion. Frontal lobe strongly elevated and swollen, with prominent median tubercle near anterior end; neck depressed and bordered laterally by pair of longitudinal elongated lobes imperfectly marked off by oblique isolated deep furrows ending in pits and almost parallel with the axial furrows, but not connected with them or with the occipital furrow. A pair of shorter parallel furrows is situated further forwards and a little more inwards on the posterior slopes of the frontal lobe of the glabella. Base of neck somewhat elevated between posterior ends of longitudinal lateral lobes. Occipital furrow wide, shallow. Occipital ring rounded, projects backwards. Surface of glabella very finely granulated. Fixed cheeks broad, feebly convex, reach up to front end of glabella, and are united in front of it by narrow band, not overhung by frontal lobe. Surface of fixed cheeks marked by 9—10 fine radiating lines, arising halfway up side of frontal lobe and running obliquely backwards or outwards; two or three are usually larger and more distinct than the rest. Facial suture oblique, cutting front margin just outside frontal lobe of glabella, and running backwards to posterior border at about 45° . Free cheeks unknown.

Thorax of six segments. Axis convex, slightly tapering, more than half as wide as pleuræ; axial rings have pair of lateral nodules. Pleuræ straight, horizontal, broad, grooved along their length.

Pygidium flattened, broadly triangular, about twice as wide as long. Axis long, narrow, reaching posterior border, rapidly tapering, conical, segmented for whole length, first 8—10 segments distinct, with obscure lateral nodules. Lateral lobes flattened, wholly segmented by pleuræ which reach border and have a faint median longitudinal ridge, but only the first 6 or 7 are distinct. First half-pleura marked off by specially strong oblique furrow. Border broad, steeply bevelled, concentrically lined with interspaces pitted.

Dimensions (of types).—

I. Length of head	.	.	.	.	15.0 mm.
Width of „ at base without free cheeks	.	.	.	.	38.0 „
II. Width of thorax	.	.	.	.	20.0 „
„ of axis	.	.	.	.	5.0 „
„ of pygidium	.	.	.	.	16.5 „
Length of „	.	.	.	.	7.5 „

Remarks.—The pygidium in Mrs. Gray's collection from Balclatchie figured by Nicholson and Etheridge (*loc. cit.*) as *Asaphus*, sp., probably belongs to this species. There is a distinct bevelled border visible on one side; the pleuræ are straight and similar to those in typical examples of *Ampyx horvati*; the axis (so far as its state of preservation permits to be seen) is similar, and the anterior border is straight

without a fulcrum. Its size is rather great, being 16 mm. in length, but not too great for some of the head-shields of *A. hornei*.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology (f. M.); Edinburgh Museum; Woodwardian Museum; Hunterian Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Ardmillan; Penwhapple Glen.

4. **Ampyx macallumi**, Salter, 1865. Plate III, figs. 11, 12.

1865. *Ampyx macallumi*, Salter, MS., Cat. Foss. Mus. Pract. Geol., p. 18.

1879. *Ampyx macallumi*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 180, pl. xii, figs. 9—12.

1899. *Ampyx macallumi*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 514, 672, etc.

Remarks.—Only the head-shield and pygidium of this species were described and figured by Nicholson and Etheridge (M., fasc. ii, 1879, p. 180, pl. xiii, f. 9—12), but some complete individuals from Dow Hill belonging to the same species render the description of the thorax now possible. Some corrections with regard to the description of the pygidium are also necessary.

In the case of the head-shield it may be remarked that there are indications of two small nodules on the base of the glabella in some of the Balclatchie specimens, but especially clear in some of the Dow Hill examples. A deep elongated pit in each axial furrow near the middle of the glabella is also noticeable in some. The frontal spine is apparently grooved as in *A. rostratus*. The genal spines probably belonging to this species are described by Nicholson and Etheridge from Balclatchie (M., *loc. cit.*, p. 182), but in some nearly complete individuals from Dow Hill similar spines are seen actually attached to the head-shield and are about twice the length of the thorax. Similar spines are found in some specimens from Ardmillan.

The thorax is about half the length of the glabella (without the frontal spine), and consists in the specimens which I have examined of only five segments. It is widest across the middle, the first segment having shorter pleuræ with very obliquely truncate ends. The axis is one third the width of the thorax and gently convex. The pleuræ are straight, horizontally extended, and in contact with the surface marked by a wide groove deepening towards the extremity, which is abruptly truncated. The first segment is rather larger than the others.

The pygidium is erroneously said to be semicircular; in the type specimen from Balclatchie as well as in all the others from that locality and from Dow Hill it is subtriangular, pointed posteriorly, with the sides rather sigmoidal in outline; and the width is twice as great as the length. The axis is broad, being nearly one third the width of the pygidium, and tapers rather rapidly to the extremity; it

has one distinct ring at the front end, but behind this it is trilobed by the presence of two longitudinal rows of 7—8 small nodules. The lateral lobes are flat and have 5—6 pleuræ slightly curved forwards indicated on them, the front ones being most distinct. The limb is strongly bevelled and striated.

Collections.—Mrs. Gray (f. M); Museum of Practical Geology, Jermyn Street; Edinburgh Museum; Hunterian Museum; Woodwardian Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie (f. M); Dow Hill; Ardmillan.

5. **Ampyx mammillatus**, Sars (e. p.) (?), 1835. Plate III, fig. 13.

1835. *Ampyx mammillatus*, Sars (e. p.); Isis, pl. viii, fig. 4 c (? f. 4 a, non 4 b, 4 d).

1854. *Ampyx mammillatus*, Angelin, Pal. Scand., p. 80, pl. xl, fig. 3.

1879. *Ampyx mammillatus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 187.

1893. *Ampyx mammillatus*, Vogdes, Amer. Geol., p. 99.

Specific Characters.—Glabella oval, rather pointed anteriorly, subcarinate, equally convex and not swollen in front but furnished with a long straight horizontal rounded spine, not grooved. Near middle of glabella is a pair of isolated lateral pits, and behind them are two oblique furrows incompletely separating off a pair of lateral longitudinal lobes with deep pits at their base. Base of glabella slightly swollen transversely. Occipital ring well marked. Fixed cheeks broad posteriorly, extend along whole length of glabella and are united in front of it as in *A. hornei*, but do not possess any radiating lines on their surface. A deep broad curved furrow separates off neck segment.

Dimensions.—

Length of head (without spine)	. . .	3.5	mm.
Width of „ at base (without free cheeks)	. . .	8.0	„
Length of frontal spine	. . .	+ 3.0	„
Width of glabella across middle	. . .	2.5	„

Remarks.—A strict adherence to the definition of *Ampyx hornei* as regards the characters of the glabella obliges us to separate this Girvan form, which, though occurring on the same horizon and at the same locality and possessing much the same general features, has a long frontal spine instead of a mere tubercle on the frontal lobe of the glabella. Nicholson and Etheridge laid so much stress on the existence of only a median tubercle instead of a spine in *A. hornei* that, unless we consider this condition to be a mark only of sex or age and the types to have all belonged to one sex or stage of development, there is no other course to follow. I have, however, only seen one well-preserved specimen with the characters here given.

Except for the presence of the frontal spine, the shape and elevation of the glabella, and absence of radiating lines on the cheeks, this form resembles *A. hornei*; but it appears more like Angelin's figure of *A. mammillatus* than any other. Angelin recognised that Sars' species *A. mammillatus* was a composite one, and accordingly separated off as *A. costatus* those represented by Sars' figures 4*a*, 4*b*, 4*d* (*op. cit.*), only retaining 4*c* as *A. mammillatus*. Nicholson and Etheridge were inclined to unite Sars' figure 4*a* with 4*c*, and so was Vogdes. Our specimen agrees closely with the species as limited by Angelin.

Collections.—Mrs. Gray; ? Museum of Practical Geology.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

6. **Ampyx mammillatus**, var. **austini**, Portlock ?, 1843. Plate III, fig. 14.

1843. *Ampyx mammillatus* var. *austinii*, Portlock, Geol. Rep. Londond., p. 261, pl. 1 B, figs. 1, 2.

Remarks.—There is one somewhat crushed head-shield in Mrs. Gray's collection from Ardmillan which appears to belong to a variety of *A. mammillatus*. It differs from typical examples of this species as above limited by the more quadrate and wider glabella, the longer lateral furrows, the more forward position of the anterior pair, and the relatively narrower fixed cheeks. The rounded frontal spine is well preserved. Though its distinctive characters may be partly due to slight vertical compression, yet it resembles Portlock's *A. austinii* more closely than it does Angelin's *A. mammillatus*, and probably should be referred to it.

Dimensions.—

Length of glabella	.	.	.	5.0 mm.
Width of „ at middle (about)	.	.	.	5.0 „
„ of fixed cheek at base (about)	.	.	.	15.0 „

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Ardmillan.

7. **Ampyx** cf. **foveolatus**, Angelin, 1852. Plate III, fig. 15.

Specific Characters.—Head-shield transverse, semicircular; anterior half of glabella projects beyond front margin; posterior margin straight. Glabella broadly oval, gently convex, rounded, with straight rounded frontal spine as long as glabella itself, and pair of lateral lobes near base incompletely marked off by oblique shallow longitudinal furrows parallel to axial furrows and deepening as they curve outwards sharply at posterior end to terminate in deep pits, behind which lie a pair of small obscure nodules at the base of the axial furrows. No other pits or furrows on the glabella. Surface sparsely granulated. Occipital ring narrow,

widening at sides, marked off by shallow curved occipital furrow. Fixed cheeks weakly convex, broadly triangular, short, extending only halfway up sides of glabella.

Dimensions.—

Length of head to base of spine	.	.	7.0 mm.
Width „ at base	.	.	15.0 „
„ of glabella at middle	.	.	6.0 „

Affinities.—This species differs from *A. hornei* in possessing a frontal spine and only one pair of furrows on the glabella, in the anterior projection of the glabella and in the shortness of the fixed cheeks. From *A. mammillatus* it differs by the shortness of the fixed cheeks and the single pair of furrows on the glabella. *A. foveolatus*, Angelin,¹ appears to agree in the projection of the glabella in front, the course of the lateral furrows marking off the lateral lobes and the pair of basal nodules; but the latter are more obscure in our single specimen, and there is no anterior pair of pits on the glabella.

Collection.—Mrs. Gray (one specimen).

Horizon and Locality.—Stiuchar Limestone Group (Llandeilo): Craighead.

8. **Ampyx** cf. **scanicus** (Angelin), 1854. Plate III, fig. 16.

Specific Characters.—Pygidium broad, subtriangular. Axis nearly one third the width of the pygidium, subcylindrical, very slightly tapering, with an obtusely pointed end, reaching posterior margin; composed of 7—8 rings of which the posterior ones are indistinct. Lateral lobes gently convex, with 3—4 very faint grooved pleuræ on their surface and one strong oblique furrow marking off articulating area along anterior margin. Border wide, steeply bent down, concentrically striated.

Dimensions.—

Length	.	.	.	.	10 mm.
Width	.	.	.	.	22 „

Remarks.—Two isolated pygidia from Shalloch Mill possess the above characters which resemble those shown in Angelin's figure of *A. scanicus*.² No head-shields of *Ampyx* from this locality have come under my notice.

Affinities.—The shape of the axis, its distinct segmentation and non-trilobation distinguish this form from *A. rostratus*, Sars.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill.

¹ Angelin, 'Pal. Scand.', p. 80, pl. xl, fig. 2; ? Pompecki, 'Beitr. z. Naturk. Preuss. Phys. Oek. Gesell. Königsberg,' 7, p. 16, pl. iv, figs. 17, 17 a.

² Angelin, 'Pal. Scand.,' pl. xl, fig. 10, p. 82 (*Raphiophorus scanicus*).

Genus **DIONIDE**, Barrande.**1. *Dionide lapworthi***, Nicholson and Etheridge, 1880. Plate IV, figs. 1, 2.

1880. *Dionide lapworthi*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. iii, p. 280, pl. xx, fig. 1.

1880. *Dionide*, sp., Nicholson and Etheridge, *ibid.*, p. 294, pl. xx, fig. 3.

1899. *Dionide lapworthi*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 517, 672, 688.

Specific Characters.—General shape elongated oval, gradually narrowing posteriorly.

Head-shield flattened, broadly semicircular, more than twice as broad as long, wider than thorax; curvature of anterior margin flattened; posterior margin almost straight. Glabella (imperfectly known) subquadrate, truncate behind, rounded in front, nearly as broad as long, weakly convex, more than two thirds the length of the head-shield and less than one third its width. Small median tubercle present. A pair of short longitudinal or slightly oblique furrows indent its base, starting from the occipital furrow and running forwards for about one third the length of the glabella, but not reaching the axial furrows. Axial furrows distinct, narrow, uniting in front of glabella. Occipital ring narrow (imperfectly known). Cheeks broad, flattened, uniting in front of glabella; surface covered with closely set small pits with obscure radial arrangement near anterior lateral portions of glabella, from which start several indistinct radiating fine lines running outwards and backwards; two of these lines are more conspicuous than the others, at first diverging and then re-uniting near the genal angles. Narrow thickened smooth border round head-shield, produced at genal angles into long straight slightly divergent spines (? grooved) reaching back as far as or beyond posterior end of body. Smooth straight neck segment behind cheeks, marked off by narrow furrow.

Thorax of six segments, narrower than head, decreasing in width posteriorly. Axis convex, as wide as pleuræ, tapering gradually; each ring furnished with transversely oval median lobe and triangular lateral lobes. Pleuræ broad, flattened, horizontal, straight, with abruptly truncate ends, and curved diagonal furrow; surface covered with coarse pits.

Pygidium very long, parabolic, of many segments. Axis tapering, wholly segmented, showing 16—20 rings similar to those of thorax. Lateral lobes of 16—20 pleuræ like those of thorax but narrower, obliquely bent back towards posterior end of pygidium and decreasing in length.

Dimensions.—

	I. (Type specimen.)	II.
Length of head	7.5 mm.	
Width of „	23.5 „	
Length of thorax	8.0 „	
Width of „ at front end	15.5 „	
Length of pygidium	10.0 „	8.0 mm.
Width of „ at front end	10.0 „	8.0 „

Remarks.—The foregoing description is based on that given by Nicholson and Etheridge, but a few more details have been added after an examination of the types and of other specimens.

The specimen figured by Nicholson and Etheridge as *Dionide*, sp., which consists of a thorax and pygidium (*suprà*, No. II), may without much hesitation be also referred to this species, *D. lapworthi*. Fragments of hypostomes probably belonging to it are also recognisable amongst the Whitehouse specimens.

Affinities.—Nicholson and Etheridge remark that this species is allied to *D. euglypta*, Angelin,¹ more closely than to *D. formosa*, Barrande,² and the pygidium also resembles that of *D. atra*, Salter,³ which is the only known part of that species. It, however, appears distinct from all, though the crushed and flattened condition of the type renders this rather uncertain. I am of opinion that its closest affinity is with *D. formosa*, the long genal spines, the radiating lines on the cheeks, and the pitting of their surface and of the pleuræ being in favour of this view, in spite of the greater breadth of the thoracic axis and narrower pygidium.

Collections.—Mrs. Gray (f. M.) ; Museum of Practical Geology ; Edinburgh Museum.

Horizon and Locality.—Whitehouse Group (M. Bala) : Whitehouse Bay.

2. *Dionide richardsoni*, sp. nov. Plate IV, figs. 3—8.

1878. *Phacops truncato-caudatus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 99, pl. vii, figs. 3, 4.

1880. *Dionide*, sp. ind. (a), Nicholson and Etheridge, *ibid.*, fasc. iii, p. 293, pl. xx, fig. 2.

Dionide, sp. ind. (d), Nicholson and Etheridge, *ibid.*, p. 295, pl. xx, fig. 5.

Specific Characters.—General shape oval, expanded in front. Head, thorax and pygidium of nearly equal length.

Head semicircular, surrounded by narrow border. Genal angles produced into

¹ Angelin, 'Pal. Scand.', p. 12, pl. ix, fig. 6 (*Polytomurus euglyptus*).

² Barrande, 'Syst. Sil. Bohême,' vol. i, p. 641, pl. xlii, figs. 24—28.

³ Salter, 'Mem. Geol. Surv.,' vol. iii, p. 321, pl. xi a, figs. 9, 9 a.

long curved spines, backwardly directed, longitudinally striated, and longer than whole body. Glabella convex, subquadrate, slightly contracted across middle,¹ as broad as long, and extending fully three fourths the length of the head-shield, truncated posteriorly. Two furrows, deep at first but rapidly growing faint, start from occipital furrow at base of glabella, run forwards rather obliquely, and die out before reaching axial furrow about halfway up sides of glabella, thus imperfectly defining a pair of triangular basal lobes. Glabella bears a strong median tubercle (? base of spine) at about one third of its length from occipital furrow. Surface of glabella finely punctate. Occipital furrow well marked. Occipital segment of moderate width. Cheeks broad, uniting in front of glabella; gently convex in centre but sloping down to sides and front. Surface of cheeks irregularly pitted. Traces of two raised nervures from sides of glabella towards genal angles. Narrow smooth border round head-shield, with a regular single row of rather larger pits just inside it. Genal spines long, curved, striated. Occipital furrow strong, curved forwards, marking off smooth segment behind cheeks.

Thorax of six segments. Axis feebly convex, about two thirds the width of pleural portion, gently tapering posteriorly. Axial rings furnished with sub-triangular lateral nodules and narrow median ridge, forming continuous raised band down middle of axis. Axial furrows strong. Pleuræ horizontally extended, straight, with truncated ends slightly bent back, and strong oblique pleural furrow. Anterior part of each pleura marked by transverse parallel closely placed rugæ; posterior part smooth and more or less swollen near axial furrow.

Pygidium parabolic, as long as wide; axis conical tapering, not quite reaching posterior margin; of 16—18 rings, of which the anterior ones possess the characters of those of the thorax. Lateral lobes flattened, horizontal; consisting of 12—15 furrowed pleuræ ornamented as in thorax, but dying out near margin.

Hypostome with broadly oval convex body, tuberculated; very narrow posterior border and expanded rounded flattened anterior wings, well marked off from body.

Remarks.—Several nearly perfect individuals as well as detached portions are now available to define this species, which varies somewhat in appearance according to its state of preservation. The glabella in the specimens figured on Pl. IV, figs. 4 and 5, are unduly wide and subcircular in appearance owing to crushing.

Affinities.—This species is very closely allied to *Dionide formosa*, Barrande,² but seems to differ in the course of the glabellar furrows, the characters of the thoracic and pygidial axis, the ornamentation of the pleuræ and of the genal spines, and the fewer segments in the pygidium. The difference in the pleural ornamentation is very marked, and Nicholson and Etheridge (M., p. 293) suspected that this form would have to be separated from *D. formosa*. The name *richardsoni*

¹ The strong constriction shown in Pl. IV, fig. 3, is largely due to the imperfect preservation of the glabella in this specimen.

² Barrande, 'Syst. Silur. Bohême,' vol. i, p. 641, pl. xlii, figs. 24—28; Suppl. i, p. 50, pl. i, fig. 18.

is accordingly suggested in honour of the Rev. Peter Richardson, of Dailly, who collected several of the specimens figured by Nicholson and Etheridge in their Monograph.

It may here be remarked that the two nervures or vascular trunks on the cheeks of *Dionide* are probably homologous with those mentioned by Grönwall¹ in *Otenocephalus laticeps*, Angelin, and *Ot. tumulus*, Grönwall. Perhaps the structures of similar appearance in *Anopyx hornei* and *Salteria primæva* are of the same nature; and Jaekel² has expressed the opinion that two vascular trunks are characteristic of all Trilobites.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum.

Horizons and Localities.—Whitehouse Group (M. Bala): Whitehouse Bay. Drummuck Group (U. Bala): Thraive Glen; Drummuck.

Family OLENIDÆ.

Genus **TRIARTHURUS**, Green.

1. *Triarthrus becki* (Green), 1832, *var.* Plate IV, fig. 10.

1832. *Brongniartia carcinodea*, Eaton, Amer. Journ. Sci., ser. i, vol. xxii, p. 166 (March).
 — *Brongniartia carcinodea*, Eaton, Geol. Text-book, p. 33, pl. i, fig. 3.
 — *Triarthrus becki*, Green, Monthly Amer. Journ. Geol., vol. i, p. 560, pl. i, fig. 3 (June).
 — *Triarthrus becki*, Green, Mon. Trilob. N.A., p. 86, cast 34, pl. i, fig. 3.
 1835. *Triarthrus becki*, Harlan, Trans. Geol. Soc. Penn., vol. i, p. 205, pl. xv, fig. 6.
 — *Paradoxides triarthrus*, Harlan, *ibid.*, p. 264, pl. xv, fig. 5.
 — *Paradoxides arcuatus*, Harlan, *ibid.*, p. 265, pl. xv, figs. 1—3.
 — *Triarthrus becki*, Harlan, Med. Phys. Researches, p. 400, pl. xv, fig. 6.
 — *Paradoxides triarthrus*, Harlan, *ibid.*, p. 401, pl. xv, fig. 5.
 — *Paradoxides arcuatus*, Harlan, *ibid.*, p. 402, pl. xv, figs. 1—3.
 1838. *Paradoxides becki*, Hall, Amer. Journ. Sci., ser. i, vol. xxxiii, p. 142, fig. 1.
 — *Triarthrus becki*, Green, *ibid.*, p. 344.
 1842. *Triarthrus becki*, Mather, Geol. New York, 1st Geol. Distr., p. 390, fig. 24 (1).
 — *Triarthrus becki*, Emmons, Geol. New York, 2nd Geol. Distr., p. 399, fig. 110 (1).
 1843. *Triarthrus becki*, Vanuxem, Geol. New York, 3rd Geol. Distr., p. 57, fig. 8 (1).
 1847. *Calymene beckii*, Hall, Paleont. New York, vol. i, p. 237, pl. lxiv, figs. 2 a—e; p. 250, pl. lxvi, figs. 2 a—k (non pl. lxvii, figs. 4 a—e).
 1848. *Calymene beckii*, Hall, Amer. Journ. Sci., ser. ii, vol. v, p. 322, figs. 1 a, b, 2 a—g.
 1855. *Triarthrus becki*, Emmons, Amer. Geol., vol. i, pt. 2, p. 214, pl. xv, fig. 12.
 1858. *Calymene beckii*, Rogers, Geol. Surv. Penn., vol. ii, p. 820, fig. 613.

¹ Grönwall, 'Bornholms Paradoxideslag' (Danmarks Geol. Unders., II Rækk. Nr. 13 [1902]), pp. 88–91, 101.

² Jaekel, 'Zeitschr. deutsch. Geol. Gesell.', vol. liii, 1901, p. 133.

1861. *Triarthrus beckii*, Barrande, Bull. Soc. Géol. France, ser. ii, p. 269, pl. v, figs. 11, 12.
 1863. *Triarthrus beckii*, Logan, Geol. Canada, p. 202, fig. 200.
 1869. *Triarthrus becki*, Linnarsson, Vestergötl. Camb. Silur. Aflagr., p. 70, pl. i, fig. 27.
 1876. *Triarthrus beckii*, Walcott, Trans. Albany Instit., vol. x, p. 23, pl. ii, figs. 1—16.
 1878. *Cheirurus*, sp., Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 107, pl. vii, fig. 19.
 1893. *Triarthrus becki*, Matthew, Amer. Journ. Sci., ser. iii, vol. xlv, p. 121, pl. i.
 — *Triarthrus becki*, Beecher, *ibid.*, pp. 361, 467.
 1894. *Triarthrus becki*, Beecher, Amer. Geol., vol. xiii, p. 38, pl. iii.
 — *Triarthrus becki*, Beecher, Amer. Journ. Sci., ser. iii, vol. xlvii, p. 298, pl. vii.
 1895. *Triarthrus becki*, Beecher, Amer. Geol., vol. xv, p. 91, pls. iv, v.
 — *Triarthrus becki*, Beecher, *ibid.*, vol. xvi, p. 166, pl. viii, figs. 12—18; pl. x, fig. 1.
 1893. *Triarthrus beckii*, Matthew, Trans. N. Y. Acad. Sci., vol. xii, p. 237, pl. viii.
 1894. *Triarthrus beckii*, Walcott, Proc. Biol. Soc. Washington, vol. ix, p. 89, pl. i.
 — *Triarthrus beckii*, Walcott, Geol. Mag., dec. iv, vol. i, p. 246, pl. viii.

Specific Characters.—Glabella subquadrate, nearly as broad as long; sides parallel; marked with two pairs of almost horizontal lateral furrows, very slightly curved, and extending more than a third across the glabella on each side. A pair of small pits in front of the anterior pair of furrows represents the first pair of lateral furrows. The anterior (true second) pair of furrows is far forward, being less than half the length of the glabella from its front end. Frontal lobe of glabella short. Occipital furrow strong, slightly arched forward in middle, and about the same distance from the posterior pair of lateral furrows as the latter is from the anterior pair. Occipital segment nearly as wide as posterior lateral lobe of glabella, and with median tubercle. Narrow border in front of glabella, projecting slightly in middle. Axial furrows straight, strong, parallel. Fixed cheeks convex, bent down, measuring at base a little over one third the width of glabella, but narrowing anteriorly; eye-lobe of moderate size, very far forward, being in front of anterior pair of lateral furrows, and marked off from cheek with strong furrow. Facial suture runs back in slight outward curve to meet posterior margin at about 75° .

Dimensions.—

Length of head-shield	4.0 mm.
„ of glabella	2.5 „

Remarks.—The minute specimen figured by Nicholson and Etheridge as doubtfully belonging to the genus *Cheirurus* (M., fasc. i, 1878, pl. vii, f. 19) must clearly be assigned to the genus *Triarthrus*. Several additional specimens from the same locality, Balclatchie, enable me to give the above fairly complete description of the head-shield.

Affinities.—This form appears to be identical with the Swedish species attributed by Linnarsson (1869) to *T. becki*, Green, which occurs typically in the Utica Slates of America. The Swedish examples appear, however, to differ slightly from the American type in having the glabella rather more quadrate and the lateral furrows and eyes rather more forward; and the Girvan specimens

agree with the Swedish in these respects. *T. angelini*, Linnarsson,¹ seems to bear a closer resemblance to the common American form, *T. becki*. *T. pygmæus*, Törnquist,² from the *Trinucleus*-Shales of Enan, has the lateral furrows more oblique and the frontal lobe larger, and *T. jemlandicus*, Linnarsson, is quite distinct.³

Collection.—Mrs. Gray (f. M.)

Horizon and Locality.—Balclatchie Group (Llandeillo) : Balclatchie ; Balclatchie Conglomerate.

(Genus **APATOKEPHALUS**, Brögger.)

1. **Apatokephalus**, sp. Plate IV, fig. 9.

1879. *Cheirurus?* sp. ind. *a*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 203, pl. xiv, fig. 11.

Specific Characters.—Pygidium subquadrate, longer than wide ; front margin almost straight ; sides subparallel ; posterior margin truncated and furnished with three pairs of short blunt points separated by shallow subangular notches (in one of the specimens in the Museum of Practical Geology there seem to be only two pairs of points). Axis convex, conical, pointed, tapering rapidly, rather more than half the length of the pygidium and one third its breadth at front end ; composed of seven or eight rings, of which only the first four or five are distinct. Lateral lobes flattened, horizontally extended, equal in width to axis at front end ; composed of three pairs of unfurrowed pleuræ bending sharply backwards at a short distance from axis and produced to form short projecting triangular points on posterior margin. First pair of pleuræ narrows posteriorly ; second pair is of nearly uniform width ; third pair is shorter and broader and in contact in middle line behind axis.

Remarks.—This minute pygidium from Balclatchie in Mrs. Gray's collection was figured by Nicholson and Etheridge as *Cheirurus?* sp. ind. *a* ; but it is scarcely necessary to point out the features by which it differs from this genus ; for no species of the latter has a pygidium with at all the same characters. The type shows more than their figure represents, for the posterior margin is preserved. With the additional light thrown by the examination of other examples of the same form the true generic position can be determined.

Affinities.—From *Remopleurides radians*, Barr.,⁴ it differs in having too many

¹ 'Vestergöt. Camb. Silur. Aflagr.,' p. 70, pl. ii, fig. 28 ; Brögger, 'Die Silur. Et. ii and iii,' p. 112, pl. iii, fig. 1.

² Törnquist, 'Siljans. Trilobitf.,' p. 38, pl. i, fig. 40 (1884).

³ Winan, "Palaönt. Notiz. No. 3," 'Bull. Geol. Institut. Upsala,' No. 11, vol. vi, pt. 1 (1902), p. 79, pl. v, figs. 5-8.

⁴ Barrande, 'Syst. Silur. Bohême,' vol. i, p. 359, pl. xliii, figs. 33-39.

axial segments and three pairs of pleuræ. It corresponds closely with the genus *Apatokephalus*, which has lately been separated by Brögger from *Dikellocephalus*.¹ A species of *Apatokephalus* has recently been described by the author from the Llandeilo beds of co. Waterford.² The British species at present attributed to *Dikellocephalus* show too many pleuræ on the lateral lobes, but the Canadian species *D. (Apato.) magnificus*, Billings,³ agrees in only having three pairs. Of the European forms, the Swedish *Apato. serratus*, Angelin,⁴ which occurs associated with the genus *Triarthrus*, as at Girvan, is apparently the nearest ally; and the examples figured by Holm (*op. cit.*) show the closest approach to the Balclatchie form. In the number of axial rings *D. (Apato.?) microphthalmus*, Linnar.,⁵ has a close agreement. Recently Wiman⁶ has created a new genus *Robeygia* for the reception of the last mentioned species, and his figure of the pygidium much resembles our Girvan specimens; but the axis is less clearly defined, less pointed, and provided with fewer rings. Wiman, moreover, associates this pygidium with head-shields bearing a considerable resemblance to *Remopleurides barrandei*. But it hardly seems advisable without further evidence to adopt his conclusions and attribute to *Remo. barrandei* the pygidium here assigned to *Apatokephalus*, though both occur at Balclatchie.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

Genus **REMOPLEURIDES**, Portlock.

1. **Remopleurides barrandei**, Nicholson and Etheridge, 1879. Plate V, figs. 1—4.

1879. *Remopleurides barrandei*, Nicholson and Etheridge, *e. p.*, Mon. Silur. Foss. Girvan, fasc. ii, p. 151, pl. x, fig. 13 (*non* figs. 14, 15, 16, *nec* pl. xi, fig. 16).

? 1879. *Remopleurides*, sp. ind (*b*), Nicholson and Etheridge, *ibid.*, p. 150, pl. x, fig. 12.

1899. *Remopleurides barrandei*, *e. p.*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 514, 673.

¹ Brögger, "Ueb. Verbreit. Euloma-Niobe Fauna," 'Nyt. Mag. f. Naturvidensk.,' vol. xxxv, 1896, p. 179.

² Reed, 'Quart. Journ. Geol. Soc.,' vol. lv, 1899, p. 758, pl. xlix, figs. 14—16 (*Tranoria punctata*); and 'Geol. Mag.,' dec. iv, vol. viii, 1900, p. 46.

³ Billings, 'Paleoz. Foss. Canada,' vol. I (1865), p. 399, fig. 376.

⁴ Angelin, 'Pal. Scand.,' p. 88, pl. xli, fig. 10; Brögger, 'Die Silur. Et. ii and iii,' p. 126, pl. iii, figs. 7—8; Holm, 'Sver. Geol. Undersök.,' ser. C, No. 176, p. 18, pl. i, figs. 3—5 (1898).

⁵ Linnarsson, 'Geol. Fören. Förhandl.,' vol. ii, 1875, p. 494, pl. xxii, fig. 3; Holm (*op. cit.*), pl. i, fig. 2.

⁶ Wiman, "Palaönt. Notiz. No. 3," 'Bull. Geol. Instit. Upsala,' No. 11, vol. vi, pt. 1 (1902), p. 77, pl. v, fig. 4.

Specific Characters.—Glabella broad, flattened, consisting of a transversely elliptical portion between the eyes and a rounded anterior tongue not bent down, nearly or quite as long as the posterior portion and slightly expanding anteriorly with a rounded non-truncate extremity and a faint median longitudinal groove on its surface. Glabella marked between eyes by three pairs of furrows placed about equal distances apart, none reaching the sides of the glabella, but all extending inwards to about the same distance and to such an extent as to leave only a narrow band down the centre. Anterior pair of furrows short, obliquely directed backwards and inwards, and at the level of the anterior end of the eyes. Second pair longer, nearly horizontal or slightly curved, and situated opposite the middle of the eyes. Posterior pair shorter than the second pair, but parallel to it, and a little in front of the base of the eyes.

Occipital furrow deep, strong, gently curved, more marked than the glabellar furrows. Occipital ring rounded, of moderate width, with central tubercle. Surface of glabella (including tongue) and of occipital ring crossed by fine transverse slightly undulating parallel lines which bend forward at the sides of the glabella. Eye-lobes strongly curved, semi-annular, narrow, extending from base of glabella to base of tongue, embracing posterior part of glabella, indenting its base on each side, and marked off by strong furrow.

Dimensions (type specimen).—

Length of glabella (including tongue)	.	.	5.0 mm.
Width of „ between eyes	.	.	5.0 „
Length of eyes	.	.	2.5 „
Distance between bases of eyes	.	.	2.5 „

Remarks.—This species was founded by Nicholson and Etheridge on several head-shields from Balclatchie, but three distinct forms were included by them under this one name. Their description of the species agrees best with the first figured specimen, but the others are completely different, and they must be removed from association with it. The type, therefore, of *R. barrandeii* is fig. 13 of pl. x in Nicholson and Etheridge's Monograph, and the amended description of this form is as given above.

The three pairs of glabellar furrows and the median one on the tongue are distinctive features. The tongue in some specimens has a wide spatulate shape, but this may be largely due to its flattening out by crushing. The remarkable ornamentation of the surface of the glabella, though clearly visible in the type, was not noticed by Nicholson and Etheridge. It is not present in any of the other specimens figured by them as belonging to this species; and these in fact possess a completely different ornamentation as well as other distinctive features, for which reasons three of them have to be removed into another species designated *R. correctus*, sp. nov. (q. v. *postea*), and one (figured by them on pl. xi, fig. 16) into a third species.

The poor specimen figured by Nicholson and Etheridge as "*Remopleurides* sp. ind. (b)" may perhaps be referable to *R. barrandeï*.

Affinities.—The transverse lineation of *R. barrandeï* recalls the somewhat similar ornamentation of *R. portlocki*, Reed,¹ which, however, cannot be considered a very closely allied form. With regard to its alliance with foreign species, *R. radians*, Barrande,² seems to have very intimate relations, the surface of the glabella being transversely striated and bearing three pairs of furrows, but the shape of the glabella is more subcircular and the anterior tongue much narrower. The Swedish examples³ of *R. radians* seem to possess, however, a shorter, more transversely urceolate glabella, and herein resemble more closely the Girvan form. *R. nanus*, Herz. v. Leucht,⁴ from the Russian Lower Ordovician, has a more subcircular glabella, shorter furrows, and apparently no transverse lineation. The head-shields of *R. microphthalmus*, Linnar., figured by Wiman,⁵ bear a close resemblance to *R. barrandeï*, but seem to be devoid of the characteristic ornamentation. The narrow band round the front end of the tongue of the glabella, which leads Wiman to create the new genus *Robergia* for its reception, does not appear to be present in *R. barrandeï*, but a similar band has been noticed in some Girvan specimens of *R. colbii*.

Collections.—Mrs. Gray; Museum of Practical Geology; Hunterian Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Dow Hill; Ardmillan.

2. *Remopleurides* (*Teratorhynchus*, s.-g. nov.) *bicornis*, sp. nov. Plate V, figs. 5—16.

Specific Characters.—Head-shield subpentagonal with the glabella much produced in front and armed with two frontal spines. Genal angles spined.

Glabella with posterior portion broad, flattened, and embraced by large semi-annular eyes; anterior portion narrower, subcylindrical, rounded, convex, not bent down in front but produced horizontally to double the length of the posterior portion with about half the width, tapering near anterior extremity, which is furnished with a slender projecting spine slightly curved upwards and about half

¹ Reed, 'Quart. Journ. Geol. Soc.,' vol. lv, 1899, p. 746, pl. xlix, fig. 4.

² Barrande, 'Syst. Silur. Böhème,' vol. i, p. 359, pl. xlii, figs. 33—39.

³ Linnarsson, 'Vestergöt. Camb. Sil. Aflagr,' pl. i, figs. 21, 22, p. 67; Törnquist, 'Siljans. Trilob.,' p. 36, pl. i, figs. 35—38.

⁴ Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' Abth. iv (1894), p. 88, pl. vi, figs. 34, 35.

⁵ Wiman, "Paläont. Notiz. 3," 'Bull. Geol. Institut. Upsala, No. 11, vol. vi, pt. 1 (1902), p. 77, pl. v, figs. 1—3.

the length of the whole glabella. At the base of this spine starts another much stouter longer spine which rises up vertically in the median plane and curves back over two thirds of the head-shield. The posterior portion of the glabella is elliptical and obscurely trilobed, being divided into three parts of subequal width by two longitudinal shallow depressions in which lie two pairs of very short oblique deep furrows; the anterior pair is situated just behind the front end of the eyes, and the posterior pair is a little behind the middle of the eyes. Each furrow ends internally in a pit. The surface of the glabella is tuberculated, but the tubercles are fewer or nearly absent along the median line of the anterior portion, and in the neighbourhood of the longitudinal depressions. Eye-lobes about one third the length of the glabella and embracing posterior portion, narrow, smooth, semi-annular, depressed, separated from glabella by deep furrow. Occipital furrow straight and strong. Occipital ring of uniform width, extending on each side beyond the longitudinal depressions on the glabella, ornamented like glabella, but with one large median tubercle. Free cheeks angulated posteriorly, the posterior margin meeting the lateral at nearly a right angle, and the genal spine not arising at this point but about halfway up the lateral margin. Genal spines long, flattened, pointed, two or three times the length of the eyes, gradually tapering, curved slightly outwards and backwards, marked with oblique longitudinal striations on under surface. Surface of free cheek swollen into convex rounded ridge, tuberculated like glabella, and running in front of and outside but not behind eye. Narrow rounded border to free cheek marked off by deep marginal groove. Eyes large, semi-annular, convex, elevated, with narrow rim at base encircled by broad shallow groove separating it from free cheek. Surface of eye furnished with numerous minute lenses arranged in diagonal rows.

Thorax with +9 (? 11) segments; axis convex, cylindrical, very slowly tapering, wider than pleuræ. Axial rings ornamented with three or four irregular rows of tubercles; posterior margin serrated; anterior margin furnished with rounded articulating crescentic band. Pleuræ falcate, weakly recurved, scarcely bent down, two thirds the width of axis; surface excavated; fulcrum about halfway out, weak, marked by elevation of anterior margin instead of by projecting knob as usual in *Remopleurides*. Extra-fulcral portion very slightly recurved, grooved, ending in point; posterior margin not distinctly notched.

Pygidium small, with short broad convex triangular axis of three segments, not reaching posterior margin; anterior ring only complete, the two posterior ones being confluent on each side but separated in centre by short strong furrow not reaching axial furrows. Pleural portions narrow, of two pairs of pleuræ. First pair broader than second, with very approximate fulcrum and beyond it bent back subparallel, terminating in rather long free points extending behind those of the second pair. Second pair of pleuræ narrow, short, touching in middle line behind axis, with short obtuse free points.

Dimensions (average example).—

Length of head to base of frontal spines . . .	14.0 mm.
" glabella " " . . .	12.0 "
Width of glabella between eyes . . .	10.0 "
" " at base . . .	5.0 "
" " in front of eyes . . .	4.0 "
Length of eyes . . .	4.0 "
" genal spine . . .	13.0 "
" lower frontal spine . . .	5.0 "

Remarks.—This very remarkable and bizarre trilobite, though it may be referred to the genus *Remopleurides* on the grounds of general resemblance in essential features, must certainly be acknowledged to mark a distinct sub-genus, the characters of which are those of this isolated species. The sub-generic name *Teratorhyuchus* is suggested for it in reference to the extraordinary development of frontal spines. The specimen of a glabella from Ardmillan in Mrs. Gray's collection which was figured by Nicholson and Etheridge (M., fasc. ii, 1879, p. 151, pl. xi, fig. 16) as an example of *R. barrandeii* is perhaps a young and immature individual of *R. bicornis*; for although the glabella seems to be evenly tuberculated and there is no sign of the two anterior spines, yet it agrees with *R. bicornis* in the size and shape of the eyes, the position of the two pairs of glabellar furrows in longitudinal depressions, and the long rounded horizontally projecting tongue. I have seen another similar specimen in Mrs. Gray's collection from the same locality. The differences between this form and the typical *R. barrandeii* as now limited are obvious.

Affinities.—This peculiar species is so distinct from all others of the genus that a detailed comparison with any of them is superfluous. The long straight anterior tongue to the glabella, horizontally extended; the two frontal spines; the two pairs of glabellar furrows in the longitudinal depressions on the glabella, the position of the genal spines, and the peculiar pygidium are the chief distinguishing characters. The relative width of the thoracic axis and pleural portions recalls *R. dorsospinifer*, and the weakness of the pleural fulcrum is like *R. obtusius*, Salter.¹ The tuberculation of the glabella reminds us of the British species *R. platycaps*, McCoy,² and *R. tuberculatus*, Reed.³

The curious curved frontal spine of *Ampyx hastatus*, Ruede.,⁴ is somewhat like that of this species. The shape of the free cheeks and lateral origin of the genal spines recall some species of *Lichas*.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilu): Dow Hill.

¹ Salter, 'Mem. Geol. Surv.,' dec. vii, pl. viii, p. 9.

² McCoy, 'Synops. Silur. Foss. Ireland,' p. 44.

³ Reed, 'Quart. Journ. Geol. Soc.,' vol. lv (1899), p. 748.

⁴ Ruedemann, 'Bull. 49, N.Y. State Mus.' (1901), pl. iii, figs. 1–10.

3. **Remopleurides colbii**, Portlock, 1843. Plate V, figs. 17, *a*, *b*.

1843. *Remopleurides colbii*, Portlock, Geol. Rep. Londond., p. 256, pl. i, fig. 1.
 1845. *Remopleurides kolbii*, Emmrich, Neues Jahrb. f. Miner., etc., p. 45.
 1846. *Remopleurides colbii*, McCoy, Synops. Silur. Foss. Ireland, p. 43.
 1854. *Remopleurides colbii*, Morris, Cat. Brit. Foss., 2nd ed., p. 115.
 1863. *Remopleurides colbii*, Salter, Mem. Geol. Surv., dec. vii, pl. viii, p. 1, figs. 1 *a*—*f*.
 1865. *Remopleurides colbii*, Salter and Woodward, Chart Foss. Crust., fig. 40.
 1877. *Remopleurides colbii*, Woodward, Cat. Brit. Foss. Crust., p. 57.
 1879. *Remopleurides colbii*?, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 146, pl. x, figs. 8, 8a.
 1899. *Remopleurides colbii*, *c. p.*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, p. 674.

Remarks.—The difficulty of distinguishing the species of *Remopleurides* by isolated heads, particularly when in the state of casts, was experienced by Salter and Nicholson and Etheridge. The original types of this species were poor, and even the material which Salter used left much to be desired. This is especially the case in the head of *R. colbii*, a species to which some specimens from Drummuck were referred by Nicholson and Etheridge. One of their figured specimens deserves a fuller description than they gave it, particularly because of its well-preserved eyes.

In this head-shield the glabella is convex from side to side and from back to front, and seems to be not quite so regularly elliptical as Salter's figures of *R. colbii* indicate, being somewhat wider at the base than elsewhere; but it is slightly distorted by oblique crushing and is only a cast. Apart from the tongue the glabella is broader than long. There are obscure traces of two pairs of oblique grooves on the surface, but I believe these are not true lateral furrows, but only superficial injuries, which their somewhat irregular position and variable depth suggest. The tongue is more than one third the length of the whole glabella, and is rather more than half as wide; it scarcely at all decreases in width anteriorly, is very strongly bent down, and is truncate at its anterior end. A furrow, interrupted in the middle, marks off a narrow anterior band on the tongue.

The eye-lobe is a very narrow band running along the side of the glabella right up to the anterior end of the tongue. The eyes are vertical, semi-annular, and indent the base of the glabella to rather less than one third its basal width, as in *R. colbii*, but they increase in width anteriorly and at their front end are as wide as the tongue is long, against which they rest—a feature not shown in Salter's figure of *R. colbii*. The lens-bearing surface of the eye is nearly vertical; the lenses are arranged in regular, closely set vertical and diagonal rows. The vertical rows near the base (not well preserved) contain about thirty lenses, and those near the

anterior end where the eye is widest forty or a few more; there are about twenty rows to a millimetre, and as the eye measures 11—12 mm. along its curved surface there are some 8000 lenses in it. Salter gave a very diagrammatic representation of the eye of *R. colbii*, which is useless for comparison as no minute description accompanied it. The lower lid or rim round the eye is a prominent narrow band marked off above and below by a deep groove. The free cheek is not well seen in this specimen.

The thorax so far as it is preserved appears to have the same characters and proportions as *R. colbii*. Only four segments are present.

In another specimen showing only the occipital ring and base of the glabella, the ornamentation of the former is seen to be indistinguishable from that of *R. colbii*.

The eye of *Remopleurides* appears to have never been minutely described, and Lindström,¹ perhaps for this reason, omits it from his list of Trilobites in a classification based on the form and structure of their eyes. Apart from these specimens of *R. colbii* referred to and described by Nicholson and Etheridge, I have seen no other representatives of this genus from Drummuck.

Dimensions (type specimen).—

Length of glabella (including tongue)	.	.	12.5 mm.
Width „ between eyes	.	.	16.0 „
Length of tongue, about	.	.	5.0 „
Width „ at base	.	.	7.0 „
Distance between bases of eyes	.	.	7.5 „

Collection.—Mrs. Gray (f. M.).

Horizon and Locality.—Drummuck Group (U. Bala) : Drummuck.

4. *Remopleurides correctus*, sp. nov. Plate VI, figs. 1—5.

1879. *Remopleurides barrandii*, Nicholson and Etheridge, *c. p.*, Mon. Silur. Foss. Girvan, fasc. ii, p. 151, pl. x, figs. 14—16 (*non* fig. 13, *nee* pl. xi, fig. 16).

1899. *Remopleurides barrandei*, *c. p.*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 514, 673.

Specific Characters.—Glabella subcircular, with two pairs of oblique lateral furrows (of which the anterior pair is sometimes merely recognisable as a pair of indistinct pits). Anterior tongue measures from two thirds to three fourths the width of the glabella and is nearly equal to it in length; expands slightly towards an abruptly

¹ Lindström, 'Kongl. Svensk. Vet. Akad. Handl.', vol. xxxiv, No. 8 (1901), p. 26.

truncated front end, and is more or less strongly bent down. Surface of glabella and tongue coarsely reticulate. Eyes strongly curved, embracing sides of glabella; palpebral lobes narrow. Occipital ring arched and ornamented with subparallel fine lines running from side to side and bent back in the middle. Free cheeks triangular, with short genal spines; half as wide as glabella, extending from neck ring to base of tongue; surface coarsely reticulate.

Dimensions (type specimen).—

Length of head	.	.	.	.	4.5 mm.
„ of glabella (without tongue)	.	.	.	.	2.5 „
Width of „ ( „ „ )	.	.	.	.	4.0 „
„ of tongue at base	.	.	.	.	3.0 „

Remarks.—The specimen figured by Nicholson and Etheridge (*op. cit.*, pl. x, fig. 16) showing the free cheek, has the latter part displaced and shifted forwards from its proper position; but this fact is not mentioned in their description of it. The real relation of the free cheek to the tongue of the glabella is the same as in *R. colbii*.

In the specimens of *R. correctus* from Dow Hill and Ardmillan, which are in the state of casts, the anterior tongue seems to be rather longer and more expanded towards the tip than in the typical Balclatchie examples; the lateral furrows are also rarely perceptible; but I believe that these differences are mainly if not wholly due to the state of preservation.

Affinities.—*R. correctus* differs from *R. barrandeii* as now limited (*v. p.* 31) by the more subcircular and less transverse shape of the glabella, by the presence of only two pairs of lateral furrows, by the reticulate ornamentation of the surface, and by the shape of the anterior tongue. Of other species *R. jentzschii*, Pompecki,¹ seems the most closely allied, but the tongue in the latter is apparently shorter and not expanded anteriorly.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Dow Hill; Ardmillan.

5. *Remopleurides dorsospinifer*, Portlock, 1843. Plate VI, fig. 6.

1843. *Remopleurides dorsospinifer*, Portlock, Geol. Rep. Londond., p. 256, pl. i, fig. 3.
 1846. *Remopleurides dorsospinifer*, McCoy, Synops. Silur. Foss. Ireland, p. 43.
 1853. *Remopleurides dorsospinifer*, Salter, Mem. Geol. Surv., dec. vii, pl. viii, figs. 3, 4.
 1854. *Remopleurides dorsospinifer*, Morris, Cat. Brit. Foss., 2nd ed., p. 115.
 1867. *Remopleurides dorsospinifer*, Salter, in Murchison's Siluria, 4th ed., p. 206, pl. xlviii, fig. 25.

¹ Pompecki, 'Die Trilobitf. Ost-, West-Preuss. Diluv. Gesch.', 1890, p. 87, pl. i, figs. 31, a, b.

1869. *Remopleurides dorsospinifer*, Linnarsson, Vestergötl. Camb. Silur. Aftagr., p. 68, pl. i, figs. 23—25.
 1877. *Remopleurides dorsospinifer*, Woodward, Cat. Brit. Foss. Crust., p. 57.
 1878. *Cheirurus* sp. ind., Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 107, pl. vii, fig. 18.
 1884. *Remopleurides dorsospinifer*, Törnquist, Undersökn. Siljans. Trilobf., p. 38 (Sver. Geol. Undersökn., ser. C., No. 66).

Remarks.—The chief features which distinguish this species from the other common Girvan forms are the long narrow slowly tapering axis with the long dorsal spine on the eighth ring, and the relatively wide pleural portions of the thorax (see Salter, *op. cit.*, 1853). The long genal spines to the head-shield and the rather narrow unfurrowed glabella are likewise characters which are noticeable. Nicholson and Etheridge figure a specimen belonging apparently to this species as *Cheirurus* sp. ind., and state that it was obtained from Drummuck, but Mrs. Gray has labelled it Balclatchie, which is much more probably correct, and the lithological character of the specimen agrees with that of the Llandeilo beds of Balclatchie.

Collection.—Mrs. Gray (f. M.).

Horizon and Localities.—Balclatchie Group (Llandeilo): Dow Hill; Balclatchie.

6. *Remopleurides longicostatus*, Portlock, 1843. Plate VI, fig. 7.

1843. *Remopleurides longicostatus*, Portlock, Geol. Rep. Londond., p. 257, pl. i, fig. 6.
 ? — *Remopleurides longicapitatus*, Portlock, *ibid.*, p. 257, pl. i, fig. 5.
 1853. *Remopleurides longicostatus*, Salter, Mem. Geol. Surv., p. 9, dec. vii, pl. viii.
 1854. *Remopleurides longicostatus*, Morris, Cat. Brit. Foss., 2nd ed., p. 115.
 1877. *Remopleurides longicostatus*, Woodward, Cat. Brit. Foss. Crust., p. 58.
 1896. *Remopleurides longicostatus*, Reed, Quart. Journ. Geol. Soc., vol. lii., p. 410.

Remarks.—The shortness of the eyes, the broad base and wide but short anterior tongue to the glabella, the absence of furrows on the surface, the wide neck ring, and the straight horizontal occipital furrow are characters which mark this species. One of the glabellas from Dow Hill measures 15 mm. in width across the middle, 10 mm. at the base, and is 12·5 mm. long. Portlock's type specimen, with which I have compared them, shows the distinguishing features well.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Dow Hill.

7. *Remopleurides salteri*, Reed, var. *girvanensis*, nov. Plate VI, figs. 8—15.

1879. *Remopleurides laterispinifer*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 149, pl. x, fig. 11, (? fig. 10); pl. xi, fig. 15.
 1899. *Remopleurides laterispinifer*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 490, 500, 509.

Remarks.—This form is exceedingly common at Dow Hill and Ardmillan, and is represented by a very large series of specimens in Mrs. Gray's collection. Nicholson and Etheridge figured some specimens of it as *R. laterispinifer*, Portlock, but the examination of two or three score examples, some of which are nearly perfect individuals, have convinced me that it does not belong to this species, but may be considered a variety of *R. salteri*.¹ In the head-shields the following characters of *R. salteri* are noticeable:—(1) tuberculation of the basal angles of the glabella; (2) tuberculation of the neck ring; (3) two pairs of curved furrows on the glabella; and (4) faint granulation of the surface of the glabella. In the smaller specimens from Girvan the relative width of the anterior tongue of the glabella agrees precisely with that of the type examples from Waterford, but in the larger specimens from Girvan the tongue is relatively wider and more strongly bent downwards. Probably this difference is only due to age.

In several specimens from Girvan head-shields possessing the above characters are found attached to thoraces which when isolated have been ascribed to *R. laterispinifer* owing to the conspicuous enlargement of the seventh pair of pleuræ. The two specimens figured by Nicholson and Etheridge from Ardmillan and Ardwell as belonging to the latter species (M., pl. x, fig. 11; pl. xi, fig. 15) should apparently be assigned to this variety of *R. salteri*; the glabella of fig. 15 does not show the characteristic two pairs of furrows, but the shell is preserved in this case, and it is only in casts that the furrows are distinct. The ornamentation of these figured specimens does not agree with that given by Salter² for *R. laterispinifer*.

In the specimens from Dow Hill the axial rings show a single row of large granules on their anterior half, with sometimes a less regular row behind; a faint transverse line is sometimes seen dividing each ring into an anterior and a posterior portion. The posterior portion is furnished with short triangular marginal spines, coarser near the sides and giving a serrated aspect to the edge. The axis is gently convex, and more than twice as wide as the pleuræ, tapering posteriorly at an angle of about 30°. The pleuræ are short and falcate, with the characteristic prominent fulcral tubercle, short oblique furrow, and free recurved point. The upper surface of the pleuræ shows a few longitudinal striations on the anterior portion, but the under surface is crossed by regular transverse equidistant striae. The seventh pleuræ are slightly stouter than the others, and are produced backwards into long, straight, tapering spines reaching to the end of the pygidium. The eighth axial ring has a strong median tubercle which may represent the base of a spine broken off short.

The pygidium is transverse, wider than long, subquadrate, with the posterior margin serrated by the four short angular points of the two pairs of pleuræ. The lateral lobes consist of these two pairs of pleuræ, which are short and curved back

¹ Reel, 'Quart. Journ. Geol. Soc.,' vol. lv (1899), p. 747, pl. xlix, figs. 1—3.

² Salter, 'Mem. Geol. Surv.,' dec. vii (1853), pl. viii, fig. 2.

strongly. The median notch on the posterior margin between the free ends of the second pair is generally larger and deeper than that between the free ends of the two pairs. The axis is represented by a pair of large rounded or subtriangular nodules almost meeting in the middle line and nearly half the width of the pygidium. A faint median elevation is generally noticeable behind them.

This Girvan species of *Remopleurides* differs from *R. laterispiniifer* in the tuberculation of the neck ring and base of the glabella, the presence of furrows on the glabella, the ornamentation of the axial rings and pleuræ, the presence of a conspicuous median tubercle on the eighth ring, and the characters of the pygidium.

Only the head-shields of *R. salteri* are known, and the points of resemblance to the Girvan form have been mentioned. None of the Waterford specimens reach the size of the majority of the Girvan examples, but this is perhaps not a matter of much importance. *R. tuberculatus*, Reed, is also allied, but not so closely as *R. salteri*. The only other species of *Remopleurides* which closely resembles the Scottish one is *R. linguatus*, Ruede.,¹ from the Trenton Conglomerate of Rysedorph.

There are a few specimens of *Remopleurides* from Minunton which appear to be attributable to this species and variety, though their preservation in limestone gives them a slightly different appearance. The shape and characters of the head-shields are identical, the basal tuberculation being often visible, but the lateral furrows are obscure or not traceable. The occipital segment and thorax have the specific ornamentation; the enlargement of the seventh thoracic pleuræ is marked, and the tubercle on the eighth axial segment is also present, while the pygidium seems to be identical; but no perfect examples have come under my notice.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian Museum.

Horizons and Localities.—Balclatchie Group (Llandeilo): Dow Hill; Ardmillan. ? Stinchar Limestone Group (Llandeilo): Minunton.

8. *Remopleurides* cf. *nanus* (Leuchtenberg), 1843. Plate VI, figs. 16, 17.

1843. *Nileus nanus*, Herz. v. Leuchtenberg, Thierreste v. Zarskoje selo, p. 13, pl. i, figs. 12, 13.

1858. *Nileus nanus*, Hoffmann, Verhandl. Miner. Gesell. St. Petersburg., pl. vii, figs. 4 a, b.

— *Remopleurides nanus*, Volborth, Verhandl. Miner. Gesell. St. Petersburg., p. 133, pl. xii, figs. 6—10.

1861. *Remopleurides nanus*, Eichwald, Leth. Ross., p. 1446.

1894. *Remopleurides nanus*, Schmidt, Rev. Ostbalt. Silur. Trilob., Abth. iv, p. 88, pl. vi, figs. 34, 35.

Remarks.—The genus *Remopleurides* is represented from Craighead by some imperfect head-shields which seem comparable to the species *R. nanus*, Leuchtenb., occurring in the Lower Ordovician of the Baltic provinces. There are three pairs

¹ Ruedemann, 'Bull. 49, N.Y. State Mus.' (1901), p. 56, pl. iii, figs. 21—29.

of well-marked, slightly arched, long lateral furrows on the glabella which has a subcircular shape with rather a broad anterior tongue (not well preserved). These furrows are distinct in the cast but less so on the surface of the shell, which is minutely punctate. On the inner side of the deep furrow separating the glabella from the band-like eye-lobe there are minute granulations at the posterior lateral angles of the glabella, succeeded anteriorly by a few fine concentric striae. The neck-ring is smooth, save for a few lateral serrations on the posterior edge. The bases of the eyes indent the sides of the glabella as in *R. colbii*, and this seems to be the only important difference from *R. nanus*, which, according to the descriptions and figures, has a similarly shaped glabella and anterior tongue, and three pairs of similar lateral furrows.

Collection.—Mrs. Gray.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo) : Craighead.

9. *Remopleurides* cf. *platyceps*, McCoy, 1846.

1846. *Remopleurides platyceps*, McCoy, Synops. Silur. Foss. Ireland, p. 44, pl. iv, fig. 2.

1854. *Remopleurides platyceps*, Morris, Cat. Brit. Foss., 2nd. ed., p. 115.

1863. *Remopleurides platyceps*, Salter, Mem. Geol. Surv., dec. vii, No. 8, p. 9.

1877. *Remopleurides platyceps*, Woodward, Cat. Brit. Foss. Crust., p. 58.

1879. *Remopleurides* sp. ind. *a*, Nicholson and Etheridge, Mon. Sil. Foss. Girvan, fasc. ii, p. 149, pl. x, figs. 9, 9 *a*.

Remarks.—The poorly preserved specimen of a portion of a glabella and thorax which Nicholson and Etheridge figured as *Remopleurides*, sp. ind. *a* (M, pl. x, figs. 9, 9 *a*), has much resemblance to *R. platyceps*, McCoy, in the tuberculated surface of the glabella and absence of furrows, but in shape it more resembles *R. colbii*. It is too imperfect for precise determination.

Collection.—Mrs. Gray (f. M.).

Horizon and Locality.—Drummuck Group (U. Bala) : Drummuck.

Genus **SHUMARDIA**, Billings.

1. *Shumardia scotica*, sp. nov. Plate IV, fig. 12.

Specific Characters.—Head-shield semi-elliptical, gently convex, a little broader than long, posterior border nearly straight; genal angles nearly rectangular, not pointed. Glabella rather more than one third the width of the head-shield and about three-fifths its length, not reaching front margin; posterior half semi-cylindrical, defined by strong straight axial furrows; anterior half broader, projecting laterally

and overhanging sides of posterior half as small lobes strongly marked off behind by deep short oblique furrows; apex of anterior half (frontal lobe) slightly pointed in front. Furrow marking off frontal lobe from cheeks narrow, weak. Occipital furrow strong, straight, marking off rather broad occipital ring with median tubercle. Cheeks convex, with neck segment marked off by strong neck furrow.

Remarks.—The genus *Shumardia* (= *Conophrys*, Callaway) has only been previously recorded from beds of Tremadoc age, including the Shineton Shales of Shropshire, the *Dictyonema*-Shales of Malvern, and the Tremadoc of Pembrofa, North Wales, in the British Isles. Abroad it has been found in Scandinavia (*Ceratopyge*-Limestone); the Tremadoc of La Montaigne Noire, S. France; and the Quebec Group of Canada. There are two head-shields of *S. scotica*, the largest 2 mm. long, in Mrs. Gray's collection from Whitehouse Bay, and these supply the materials for the above description.

Affinities.—This species differs from *S. salopiensis*, Callaway ('Quart. Journ. Geol. Soc.,' vol. xxxiii, 1877, p. 667, pl. xxiv, fig. 7) by the slightly pointed form of the glabella, in which feature it agrees with *S. miqueli*, Pompecki ('Neues Jahrb. f. Miner., etc.,' 1902, vol. i, p. 5, figs. 2 *a, b*); but in other respects it seems closely allied to the Shineton form.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

Genus **SALTERIA**, Wyville Thomson.

1. **Salteria primæva**, Wyville Thomson, 1864. Plate IV, figs. 13, 14.

1864. *Salteria primæva*, Wyville Thomson, Mem. Geol. Surv., dec. xi, pl. vi, p. 1.

1876. *Salteria primæva*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.

1878. *Salteria primæva*, Etheridge, jun., Proc. Roy. Phys. Soc. Edinburgh, vol. iv, p. 170.

1879. *Salteria primæva*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan., fasc. ii, p. 199, pl. xiv, fig. 5.

1899. *Salteria primæva*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 674.

Specific Characters.—The diagnosis of this species given by Wyville Thomson is as follows:—"S. fere uncialis, lata, ovata. Caput semilunare, limbo angusto, brevi, convexo, marginato; glabellâ ovatâ, pyriformi, depressâ, genis multo majori, utrinque puteis tribus brevibus notatâ; sutura facialis sub fronte ambitui parallelâ, dein per quartam partem externam limbi conspicua subverticalis. Thorax articulis truncatis. Cauda triangularis multisegmentata."

Dimensions.—

Length of head-shield	.	.	.	8.5 mm.
Width of middle-shield	.	.	.	16.0 „

Remarks.—A few more additions to our knowledge of this peculiar trilobite can be made by means of Mrs. Gray's specimens. In one head-shield (Pl. IV, fig. 13), there is a small median tubercle on the glabella a little behind the posterior pair of pits, which are connected by a pair of short curved furrows with the posterior margin; the narrow pre-glabellar area is crossed by 5—6 distinct rugæ on each side with a smooth median space between the two sets; and there seem to be 2—3 fine raised lines or nervures radiating backwards over the cheek from the side of the glabella opposite the anterior pair of pits. No trace of free cheeks is preserved. The characteristic lineation on the neck segment behind the fixed cheeks is well preserved.

In another specimen (Pl. IV, fig. 14) we see a nearly complete individual, the head only being imperfect anteriorly. The thorax shows six or seven segments, and the axis gradually tapers posteriorly. Nicholson and Etheridge remarked that there were at least six thoracic segments; and they also noticed the fine raised oblique lines crossing the grooved pleuræ, which are well shown in this specimen. The semicircular pygidium, of which Wyville Thomson only had a fragment for description, shows a tapering axis of 10—12 rings, of which the first 4—5 show an obscure trilobation; the lateral lobes possess a half-pleura on the front edge followed by 6—7 pairs of complete simple unfurrowed pleuræ reaching the raised angular border and separated by strong interpleural furrows from one another. Only the first four pairs of pleuræ correspond with the axial rings.

Affinities.—The true relations of this genus have always been difficult to decide. Wyville Thomson (*op. cit.*) was inclined to regard it as intermediate between *Trinucleus* and some of the Olenidæ. With regard to the head-shield the affinity seems to be with *Ampyx*, as suggested by the general characters, the course of the facial sutures, the simple glabella with pits, the cheeks with nervures, absence of eyes, etc.

Collections.—Mrs. Gray; Museum of Practical Geology; Hunterian Museum.

Horizon and Localities.—Balclatchie Group (Llandilo): Balclatchie; Penwhapple Glen.

Genus **TELEPHUS**, Barrande.

1. **Telephus fractus**, Barrande, 1852. Plate IV, fig. 11.

1852. *Telephus fractus*, Barrande, Syst. Silur. Bohême, vol. i, p. 890, pl. xviii, figs. 30—34.

: 1854. *Telephus wegelini*, Angelin, Pal. Scand., p. 91, pl. xli, fig. 23.

1884. *Telephus fractus*, Törnquist, Undersökn. Siljans. Trilobitf., p. 89.

Specific Characters.—The description given by Barrande (*op. cit.*) may be summarised as follows:—Head very strongly swollen in a transverse direction.

Glabella oval, truncated at base, tuberculated; no lateral furrows. Axial furrows deep, distinct, arched, surrounding glabella. Occipital furrow well marked, straight. Occipital ring well developed, elevated as high as glabella, provided with strong median spine inclined backwards. Cheeks triangular, rounded, smooth, widest near front. Narrow flattened border of almost uniform width extends round cheeks and front of head-shield, where are two small downwardly bent spines. Thorax unknown. Pygidium semicircular, strongly arched. Axis convex, conical, rounded, one third the width of the pygidium and extending two thirds its length; three segments, of which the last two are scarcely separated. Lateral lobes smooth, not segmented, inclined downwards. Narrow flattened border round margin.

Remarks.—Only the head-shield is known from the Girvan area, and three imperfect specimens have come under my notice. These are flattened by pressure; the glabella seems to be subquadrate in shape; the neck-spine is preserved in one specimen, but the anterior marginal spines are not visible.

This peculiar and imperfectly known trilobite occurs in the beds of Whitehouse Bay in association with *Cyclopyge rediviva*, *C. armata*, *Dionide richardsoni*, etc. In Bohemia it occurs on the same horizon with the same two first-mentioned species and with *Dionide formosa*, which is closely allied to *D. richardsoni*.

Linnarsson¹ identified *T. wegelini* with *T. fractus*, and Törnquist (*op. cit.*) records the species from the *Trinucleus*-Shales of Sweden.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

Family ASAPHIDÆ.

Genus **ASAPHUS**, Brongniart.

1. **Asaphus (Isotelus) gigas**, De Kay, 1824. Plate VII, fig. 1.

- ? 1823. *Asaphus platycephalus*, Stokes, Trans. Geol. Soc. Lond., ser. 2, vol. i, p. 208, pl. xxvii.
- 1824. *Isotelus gigas*, De Kay, Ann. Lyceum Nat. Hist. New York, vol. i, p. 176, pl. xii, fig. 1.
- 1826. *Asaphus gigas*, Dalman, Palæad., p. 70.
- *Asaphus planus*, Dalman, *ibid.*, p. 70.
- 1832. *Isotelus gigas*, Green, Mon. Trilob. N. Amer., p. 71, casts 21, 22.
- *Isotelus planus*, Green, *ibid.*, p. 68, cast 23.
- *Isotelus stegops*, Green, *ibid.*, p. 71, casts 26, 27.
- *Brongniartia isotelea*, Eaton, Geol. Text-book, p. 33, pl. ii, fig. 22.
- 1835. *Asaphus platycephalus*, Bronn, Leth. Geogn., vol. i, p. 115, pl. ix, fig. 8.
- 1840. *Isotelus gigas*, Milne Edwards, Crust., vol. iii, p. 298.
- *Asaphus platycephalus*, Buckland, Geol. and Min., vol. ii, p. 76, pl. xiii, fig. 12.

¹ Linnarsson, 'Jemförel. mel. d. silur. Aflagr. i Dalarna,' p. 350 (1871).

1843. *Asaphus platycephalus*, Burmeister, Organ. Trilob., p. 110, pl. ii, fig. 12.
 — *Isotelus gigas*, Portlock, Geol. Rep. Londond., p. 295, pl. vii, fig. 1.
 — *Isotelus planus*, Portlock, *ibid.*, pl. vii, figs. 2—4, and pl. viii, figs. 1, 4, 7 (*non* figs. 2, 3, 6).
 — *Isotelus ovatus*, Portlock, *ibid.*, pl. viii, fig. 5.
 — *Isotelus sclerops*, Portlock, *ibid.*, pl. x, figs. 1, 2.
 — *Isotelus powisii*, Portlock, *ibid.*, p. 297, pl. vi, fig. 1.
 1846. *Isotelus gigas*, McCoy, Synops. Silur. Foss. Ireland, p. 53.
 1847. *Isotelus gigas*, Hall, Palaeont. New York, vol. i, p. 231, pls. lx—lxiii.
 1854. *Asaphus (Isotelus) gigas*, Morris, Cat. Brit. Foss., 2nd ed., p. 100.
 1855. *Isotelus gigas*, Emmons, Amer. Geol., vol. i, pt. 2, p. 215, pl. xvi, fig. 12.
 1858. *Isotelus gigas*, Rogers, Geol. Surv. Penn., vol. ii, p. 819, fig. 610.
 1863. *Isotelus gigas*, Billings, Geol. Canada, p. 184, fig. 182.
 ? — *Isotelus platycephalus*, Billings, *ibid.*, fig. 183.
 1864. *Asaphus (Isotelus) gigas*, Salter, Mem. Geol. Surv., dec. xi, pl. iii.
 1865. *Asaphus (Isotelus) gigas*, Salter, Mon. Brit. Trilob., p. 161, pl. xxiv, figs. 1—5; (?) pl. xxv, fig. 5.
 1870. *Asaphus platycephalus*, Billings, Quart. Journ. Geol. Soc., vol. xxvi, p. 486, pls. xxxi, xxxii.
 1877. *Asaphus (Isotelus) gigas*, Woodward, Cat. Brit. Foss. Crust., p. 25.
 1894. *Asaphus (Isotelus) gigas*, Clarke, Lower Silur. Trilob. Minnesota, Final Rep. Geol. Nat. Hist. Surv. Minnes., vol. iii, pt. ii, p. 701.

Remarks.—It is highly doubtful if Salter's *Asaphus gigas* is identical with De Kay's species, but I am not in a position to decide this point. However, there are a few head-shields and pygidia with fragments of the thorax from Girvan which must be referred to the same form as Salter's *Asaphus gigas*. A well-preserved head-shield from Ardmillan shows the characteristic features seen in Portlock's *Isot. sclerops* which Salter ascribes to *A. gigas*. This form differs from the commoner Girvan *Isotelus* in a manner described under *I. instabilis*; but the pygidia are generally too poorly preserved to decide with certainty their specific position.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizon and Locality.—Balclatchie Group (Llandeilo): Ardmillan.

2. *Asaphus (Isotelus) instabilis*, sp. nov. Plate VII, figs. 2—8.

1879. *Asaphus gigas*?, Nicholson and Etheridge, *c. p.*, Mon. Silur. Foss. Girvan, fasc. ii, p. 153, pl. x, figs. 18, 19.
 1899. *Asaphus gigas*, *c. p.*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 513, 514, etc.
 ? 1899. *Asaphus rectifrons*, *ibid.*, pp. 671, 674.

Specific Characters.—Head-shield broadly parabolic, about twice as wide as long, gently convex. Glabella feebly convex, faintly defined, hour-glass shaped, contracted between the eyes, rounded in front, smooth, about one-third the width of head-shield at base. Axial furrows weak, curve inwards in their forward course

to eyes, in front of which they are obsolete. Eyes situated close to glabella at about two-fifths of its length, and therefore nearer posterior than anterior margin of head-shield. Eye-lobes of moderate size, rounded, prominent, upturned. Facial sutures unite in regular curve in front of glabella, curve at first strongly outwards and then inwards to eyes, behind which they bend again sharply outwards to cut posterior margin at angle of about 35° — 45° at less than half the distance between glabella and genal angle. Free cheeks triangular, convex, with slightly flattened lateral border and genal angle furnished with a short backwardly directed spine.

Thorax with cylindrical axis as wide as the pleuræ. Pleuræ consist of inner horizontal straight portion and outer extra-fuleral portion bent downward and slightly backward. Fulcrum situated nearly halfway out at junction of inner and outer portions. Pleural groove strong, deep, wide, extending only about two thirds the length of pleura. Extremity of outer portion of pleura flattened, rounded, or subtruncate, with "Pander's organ" near front margin represented by small oval tubercle.

Pygidium broadly parabolic (or semicircular in immature individuals), feebly convex; front margin slightly arched forward; lateral angles obliquely truncated by inclined articulating facet. Axis about one third the width of the pygidium at front end, and extending fully three fourths its length; weakly convex, tapering rather rapidly, especially at first, to a blunt slightly raised apex. Faint traces of several annulations on axis (visible in casts). Lateral lobes slightly bent down, with faint traces of several pleuræ (visible in casts). Fulcrum situated at about one third of the distance from axis to lateral margin, with strong oblique groove behind it. Fascia about one fifth the length of pygidium, concave, with the striae meeting behind axis at obtuse angle and extending slightly over to convex surface of pygidium.

Remarks.—In every collection which I have examined there are head-shields, pygidia, and portions of thoraces (with occasional hypostomes) which are referable to some species of *Asaphus* allied to *A. gigas*, De Kay, *A. scutalis*, Salter, and *A. rectifrons*, Portlock, and yet showing points of difference which forbid our placing them in any one of these species. Nicholson and Etheridge were doubtful if they could be referred to *A. gigas* (M., fasc. ii, p. 153). The head-shields plainly indicate the sub-genus *Isotelus* by the absence of neck furrow, occipital furrow, and neck-ring. The free cheeks are also typically those of *Isotelus*. Several small specimens—probably immature—from Dow Hill in Mrs. Gray's collection consist of head-shields with several thoracic rings attached, or of pygidia with several segments of a similar thorax, so that we are able to reconstruct the complete individual.

All these specimens appear to have been previously attributed to *A. gigas*; but the head-shields differ from *A. gigas* by being broader and more transverse, by the more backward position of the eyes, by the posterior branch of the facial suture

cutting the posterior margin of the head-shield much further out, by the axial furrows being weaker and more curved outwards (in adult examples) behind the eyes, and by the distinctly spined genal angles. Clarke¹ has remarked that the usual basis of distinction between *A. gigas*, De Kay, and *A. maximus*, Locke, is that the former has no genal spines, while the latter possesses them. Schmidt² considers *Isot. remigium*, Eichw., to be closely allied to Salter's *Isot. gigas*; but there is considerable doubt if Salter's *Isot. gigas* is the same as De Kay's *Asaphus gigas*.

With *A. scutalis*, Salter,³ this Girvan form agrees in the shape of the head-shield, the axial furrows, and the proportions of the glabella, but the eye is rather further back, and the facial suture bends out rather more sharply behind the eye and cuts the posterior margin at a more acute angle.

The head is not as broad as in *A. rectifrons*, Portl.,⁴ nor the eye as far back. In neither *A. scutalis* nor *A. rectifrons* are the genal angles spined, but in *Isot. platyrhachis*, Steinhardt,⁵ which in cranial respects appears closely allied to this Girvan form, this feature is found. The smaller specimens of *A. maximus*, Locke, bear a considerable resemblance to *A. instabilis*, but the head-shield seems to be narrower and more pointed.

With regard to the thorax, the axis is narrower than in *I. platyrhachis*, but is about the same width as in *A. scutalis*. The fulcrum in the latter species is, however, nearer the axis than in the Girvan form, and the pleural groove less strong. Moreover the axis of the pygidium is narrower in *A. scutalis* and has a double row of 10—11 puncta, and the caudal fascia is broader. The pygidium of the Girvan form bears some resemblance to *A. rectifrons*, Portlock, as interpreted by Salter,⁶ the pygidium being attributed to *Isot. arcuatus* by Portlock.⁷ There seems to be much difference of opinion as to what is the typical shape of the pygidium in the American allied species *A. gigas* and *A. maximus*. The British form called *A. gigas* has too parabolic a pygidium for either, and the axis shows no segmentation. According to Clarke (*op. cit.*) mature individuals in the above-mentioned species lose the segmentation, so that its presence or absence is merely a sign of age. Schmidt⁸ says that the genus (or sub-genus) *Isotelus* occurs exclusively in the higher Ordovician beds (except the doubtful *Isot. ? stacyi*, Schm.), but this is certainly not the case in the British Isles.

¹ Clarke, "Lower Silur. Trilob. Minnesota," 'Final Rep. Geol. Nat. Hist. Surv. Minnes.,' vol. iii, 1894, pt. ii, p. 701.

² Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' Abth. v (1901), p. 90, pl. x, fig. 17; pl. xi, figs. 1—7.

³ Salter, 'Mon. Brit. Trilob.,' p. 169, pl. xxv, figs. 2, 3.

⁴ Portlock, 'Geol. Rep. Londond.,' p. 298, pl. ix, figs. 1 *a*, *b*, and pl. viii, figs. 2, 3, 7.

⁵ Steinhardt, 'Preuss. Trilob.,' p. 248, pl. i, fig. 10. Schmidt, *op. cit.*, p. 91, pl. x, figs. 13—16; pl. xi, fig. 8.

⁶ Salter, *op. cit.*, p. 166, pl. xxv, fig. 8.

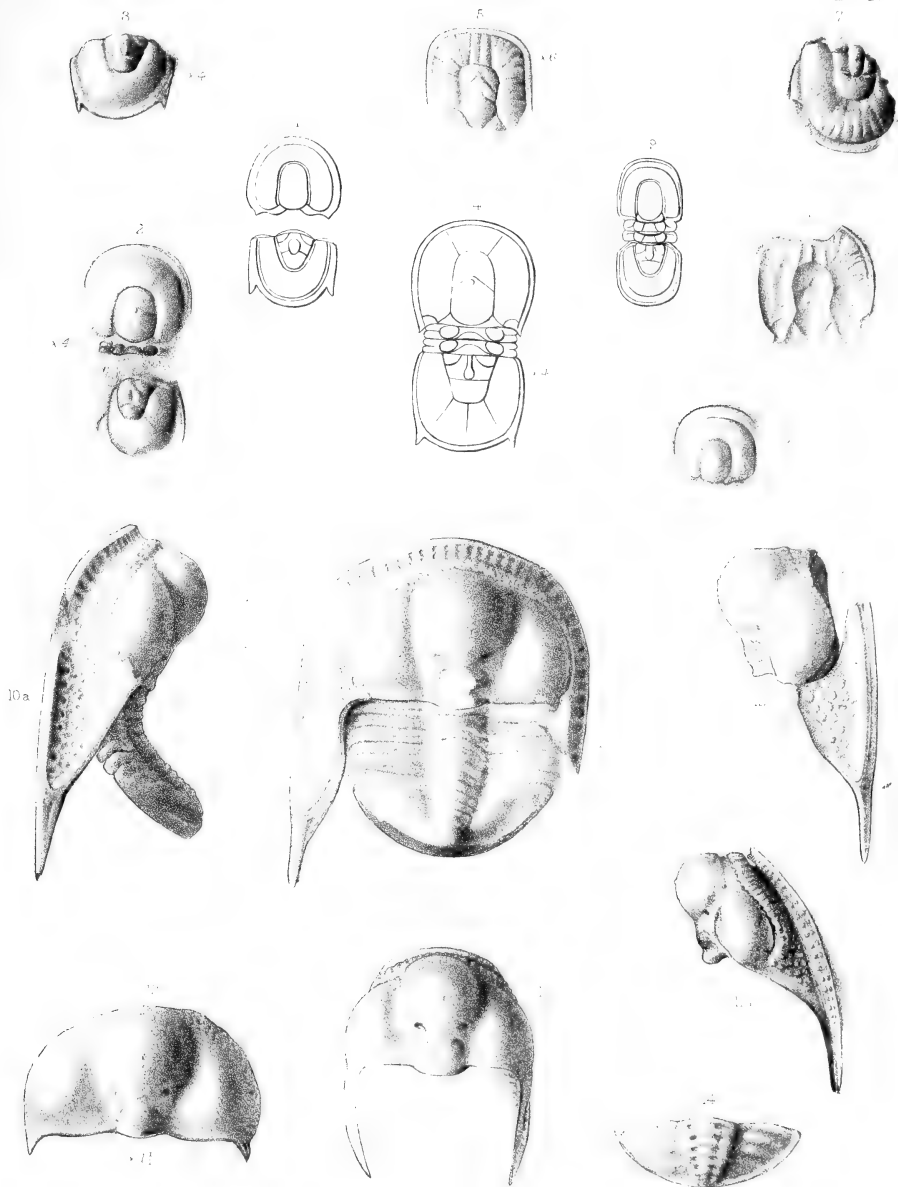
⁷ Portlock, *op. cit.*, pl. ix, figs. 2, 3.

⁸ Schmidt, *op. cit.*, p. 87.



PLATE I.

FIG.		PAGE.
	Agnostus agnostiformis (M'Coy).	3.
1.	Outline restoration of head-shield and pygidium, after Salter, 'Mem. Geol. Surv.,' dec. xi, pl. i, figs. 8 <i>a</i> , 10 <i>a</i> .	
	Agnostus girvanensis , sp. nov.	4.
2.	Imperfect individual with one thoracic segment in position. \times 4. Balclatchie. Mrs. Gray's Collection.	
3.	Pygidium showing median ridge and tubercle on axis. \times 3. Balclatchie. Museum of Practical Geology.	
4.	Outline restoration of complete individual.	
	Agnostus perrugatus , Barrande.	6.
5.	Nearly perfect head-shield. \times 6. Whitehouse. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' fasc. iii, pl. xx, fig. 6.)	
6.	Impression of head-shield. \times 3. Whitehouse. Mrs. Gray's Collection.	
7.	Imperfect pygidium. \times 5. Whitehouse. Mrs. Gray's Collection.	
	Agnostus tardus , Barrande.	7.
8.	Head-shield. \times 6. Whitehouse. Mrs. Gray's Collection.	
9.	Outline restoration of complete individual, after Barrande ('Syst. Sil. Bohême,' vol. i, pl. xlix, fig. 1 <i>b</i>).	
	Trinucleus bucklandi , Barrande.	10.
10.	Complete individual, showing genal prolongation of fringe, character of pits, etc. \times 2. Drummuck. Mrs. Gray's Collection.	
10 <i>a</i> .	Side view of same.	
11.	Head-shield, showing projection of glabella, lateral pits, tubercle and bending down of fringe. \times 2. Drummuck. Mrs. Gray's Collection.	
11 <i>a</i> .	Side view of same, showing radial arrangement of pits and groove in fringe where shell is removed.	
12.	Side view of head-shield, showing genal portion of fringe and spine with shell preserved, as in fig. 10 <i>a</i> . \times 2. Drummuck. Museum of Practical Geology.	
13.	Head-shield with fringe wanting, showing minute pitting on cast where shell is removed. \times 1½. Drummuck. Museum of Practical Geology.	
14.	Pygidium, showing paired pits between rings on axis. \times 3. Drummuck. Museum of Practical Geology.	



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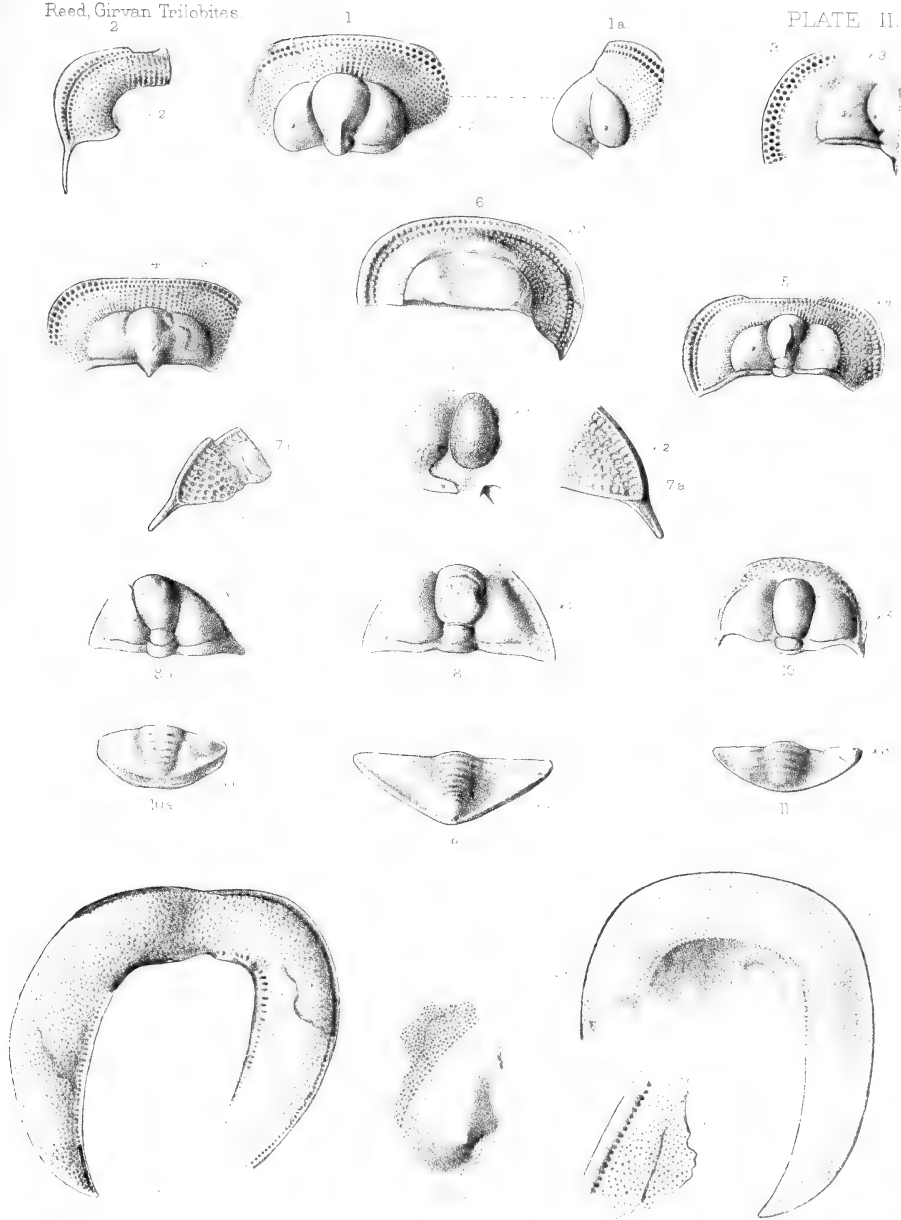
West Newman imp.

PLATE II.

FIG.		PAGE.
	<i>Trinucleus subradiatus</i>, sp. nov.	12.
1.	Head-shield (imperfect), showing sharply carinated glabella with two pairs of short broad furrows, cheeks with "ocular tubercle" and eye-line, fringe with two marginal concentric rows of large pits and inner radial rows of smaller pits. × 3. Dow Hill. Mrs. Gray's Collection.	
1 a.	Side view of same, showing shape and elevation of glabella. × 3.	
2.	Portion of fringe, showing contour and genal spine. × 2. Dow Hill. Mrs. Gray's Collection.	
3.	Portion of head-shield, showing neck segment and nuchal spine. × 3. Dow Hill. Mrs. Gray's Collection.	
4.	Head-shield, showing nuchal spine, etc. × 3. Dow Hill. Mrs. Gray's Collection.	
5.	Cast of head-shield, showing carinated glabella, radial rows of small pits on inner portion of fringe, and general shape of fringe. × 4. Dow Hill. Mrs. Gray's Collection.	
6.	Cast of fringe, showing marginal concentric and inner radial rows of pits, inward curvature, and backward prolongation of genal angle. × 3. Dow Hill. Woodwardian Museum.	
	<i>Trinucleus</i>, sp. (a).	14.
7.	Portion of head-shield, showing frontal lobe of glabella with surface coarsely reticulated, cheek with similar ornamentation and tubercle, and fragment of fringe. × 3. Shalloch Mill. Mrs. Gray's Collection.	
7 a.	Genal portion of fringe and spine. × 2. Shalloch Mill. Mrs. Gray's Collection.	
7 b.	Genal portion of fringe and spine, with part of cheek attached. × 2. Shalloch Mill. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' fasc. ii, pl. xiv, fig. 2.)	
	<i>Trinucleus</i>, sp. (b).	14.
8.	Head-shield, nearly perfect, showing neck of glabella formed of one lobe, and fringe with only two rows of pits. × 2. Whitehouse. Mrs. Gray's Collection.	
8 a.	Head-shield with similar features. × 2. Shalloch Mill. Mrs. Gray's Collection.	
	<i>Trinucleus</i>, sp. (c).	15.
9.	Pygidium with numerous rings on axis. × 2. Shalloch Mill. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' fasc. ii, pl. xiv, fig. 4.)	
	<i>Trinucleus</i>, sp. (d).	15.
10.	Head-shield, showing glabella with elongated frontal lobe, short neck, and numerous small pits on fringe. × 5. Whitehouse. Mrs. Gray's Collection.	
10 a.	Pygidium, showing pits between rings on axis. × 6. Whitehouse. Mrs. Gray's Collection.	
	<i>Trinucleus</i>, sp. (f).	16.
11.	Pygidium with broad rounded axis. × 3. Shalloch Mill. Mrs. Gray's Collection.	
	<i>Harpes flanaganii</i>, Portlock.	8.
12.	Horse-shoe limb, showing single row of large pits inside narrow border. × 3. Ardmillan. Mrs. Gray's Collection.	
12 a.	Portion of limb and cheek bearing eye and showing radiating rows of minute punctures. × 4. Dow Hill. Mrs. Gray's Collection.	
	<i>Harpes</i>, sp. (a).	9.
13.	Portion of fringe, showing strong rounded border and single row of pits inside it. × 2. Shalloch Mill. Mrs. Gray's Collection.	
	<i>Harpes</i>, sp. (b).	9.
14.	Horseshoe limb, nearly complete, showing narrow smooth rim and irregularly arranged minute pits on surface of limb, and fine radiating lines of punctures on cheeks. × 3. Bargany Pond Burn. Mrs. Gray's Collection.	

Reed, Girvan Trilobites.

PLATE II.



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TRINUCLEUS AND HARPES

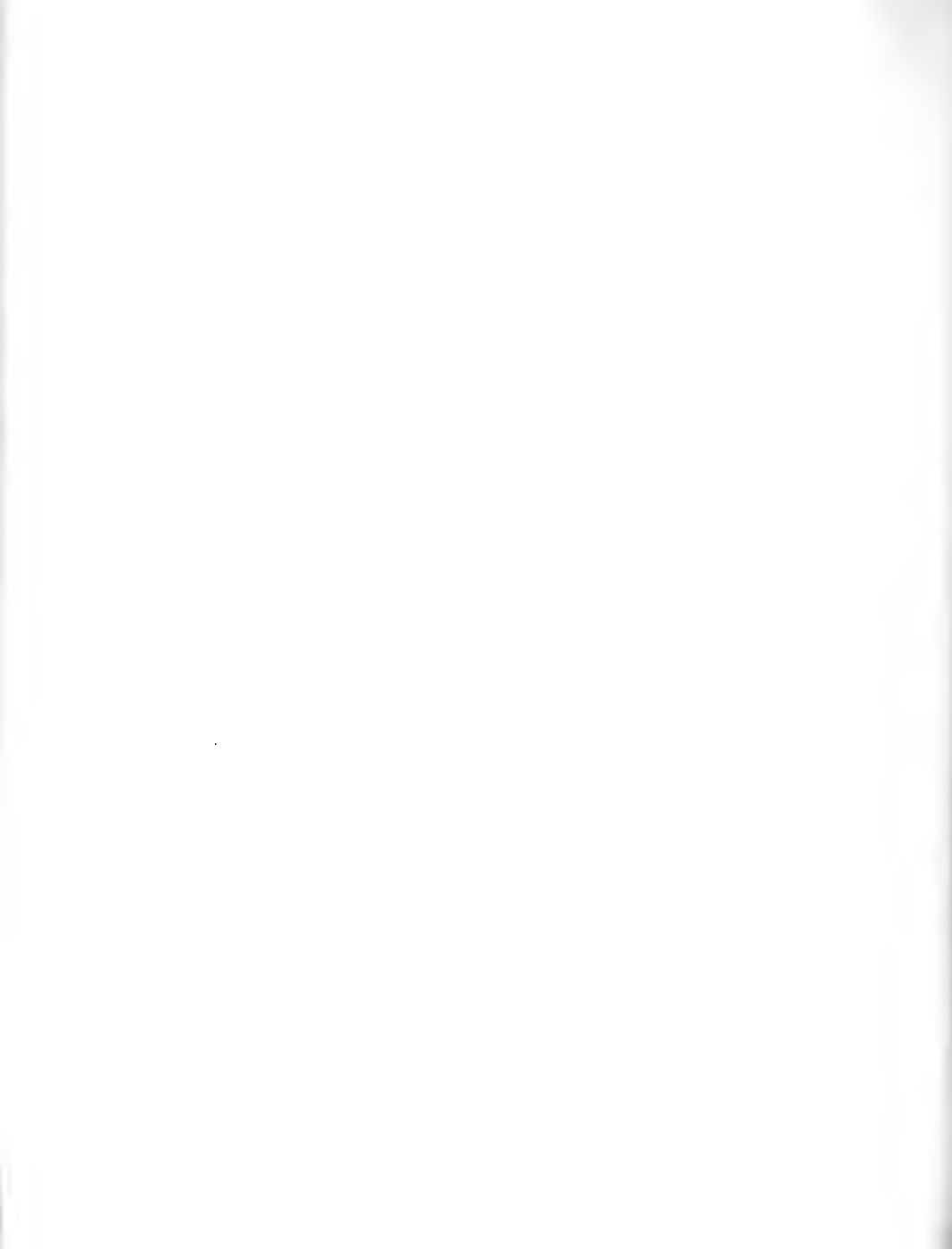


PLATE III.

- | Fig. | | PAGE. |
|------|---|-------|
| | <i>Ampyx drummuckensis</i>, sp. nov. | 18. |
| 1. | Head-shield, nearly perfect, showing frontal and genal spines and coarse punctation of surface where shell is removed. $\times 2$. Drummuck. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' fasc. ii, p. 178, pl. xiii, fig. 1, as <i>Ampyx rostratus</i> .) | |
| 2. | Head-shield and portion of thorax, showing length of frontal spine. $\times 2$. Drummuck. Mrs. Gray's Collection. | |
| 3. | Head-shield, imperfect, showing two pairs of pits at sides of glabella and one pair near base. Surface of cast shows coarse punctation. $\times 2$. Drummuck. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, <i>op. cit.</i> , fasc. ii, p. 178, pl. xiii, figs. 2, 2a, as <i>Ampyx rostratus</i> .) | |
| 4. | Pygidium, showing segmental and tuberculated axis and smooth lateral lobes. $\times 2\frac{1}{2}$. Drummuck. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, <i>op. cit.</i> , fasc. ii, p. 178, pl. xiii, fig. 3, as <i>Ampyx rostratus</i> .) | |
| 5. | Completely enrolled individual, showing pygidium and head-shield in contact, thorax, etc. $\times 2\frac{1}{2}$. Drummuck. Mrs. Gray's Collection. | |
| | <i>Ampyx depressus</i> (Angelin). | 17. |
| 6. | Head-shield, showing faint nodules at base of glabella and grooved frontal spine. $\times 6$. Whitehouse Bay. Mrs. Gray's Collection. | |
| 7. | Ditto. $\times 6$. Whitehouse Bay. Mrs. Gray's Collection. | |
| | <i>Ampyx hornei</i>, Etheridge, jun., and Nicholson. | 19. |
| 8. | Head-shield, perfect, showing tubercle and lateral lobes of glabella and radiating lines on cheeks. $\times 1\frac{1}{2}$. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' fasc. ii, p. 184, pl. xiii, fig. 6.) | |
| 9. | Ditto. $\times 2$. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, <i>op. cit.</i> , fasc. ii, pl. xiii, fig. 4.) | |
| 10. | Portion of thorax and pygidium. $\times 2$. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, <i>op. cit.</i> , fasc. ii, pl. xiii, fig. 7.) | |
| | <i>Ampyx macallumi</i>, Salter. | 21. |
| 11. | Nearly perfect individual, showing head-shield with grooved frontal spine, faint nodules at base of glabella, thorax, and pygidium. $\times 2$. Dow Hill. Mrs. Gray's Collection. | |
| 12. | Pygidium, showing trilobed axis and curved pleurae on lateral lobes. $\times 3$. Dow Hill. Mrs. Gray's Collection. | |
| | <i>Ampyx mammillatus</i>, Sars (?). | 22. |
| 13. | Head-shield, nearly complete, showing rounded frontal spine, one pair of pits, and oblique furrows on glabella. $\times 5$. Balclatchie. Mrs. Gray's Collection. | |
| | <i>Ampyx mammillatus</i>, var. <i>austini</i>, Portlock (?). | 23. |
| 14. | Head-shield, imperfect and slightly crushed, showing two pairs of furrows on the glabella. $\times 2\frac{1}{2}$. Ardmillan. Mrs. Gray's Collection. | |
| | <i>Ampyx cf. foveolatus</i>, Angelin. | 23. |
| 15. | Head-shield, nearly perfect, showing short broad cheeks, prominent broad glabella, with oblique angulated furrows, faint basal nodules, and rounded frontal spine. $\times 2\frac{1}{2}$. Craighead. Mrs. Gray's Collection. | |
| | <i>Ampyx cf. scanicus</i> (Angelin). | 24. |
| 16. | Pygidium, showing broad obtuse axis and faintly segmented lateral lobes. $\times 2$. Shalloch Mill. Mrs. Gray's Collection. | |

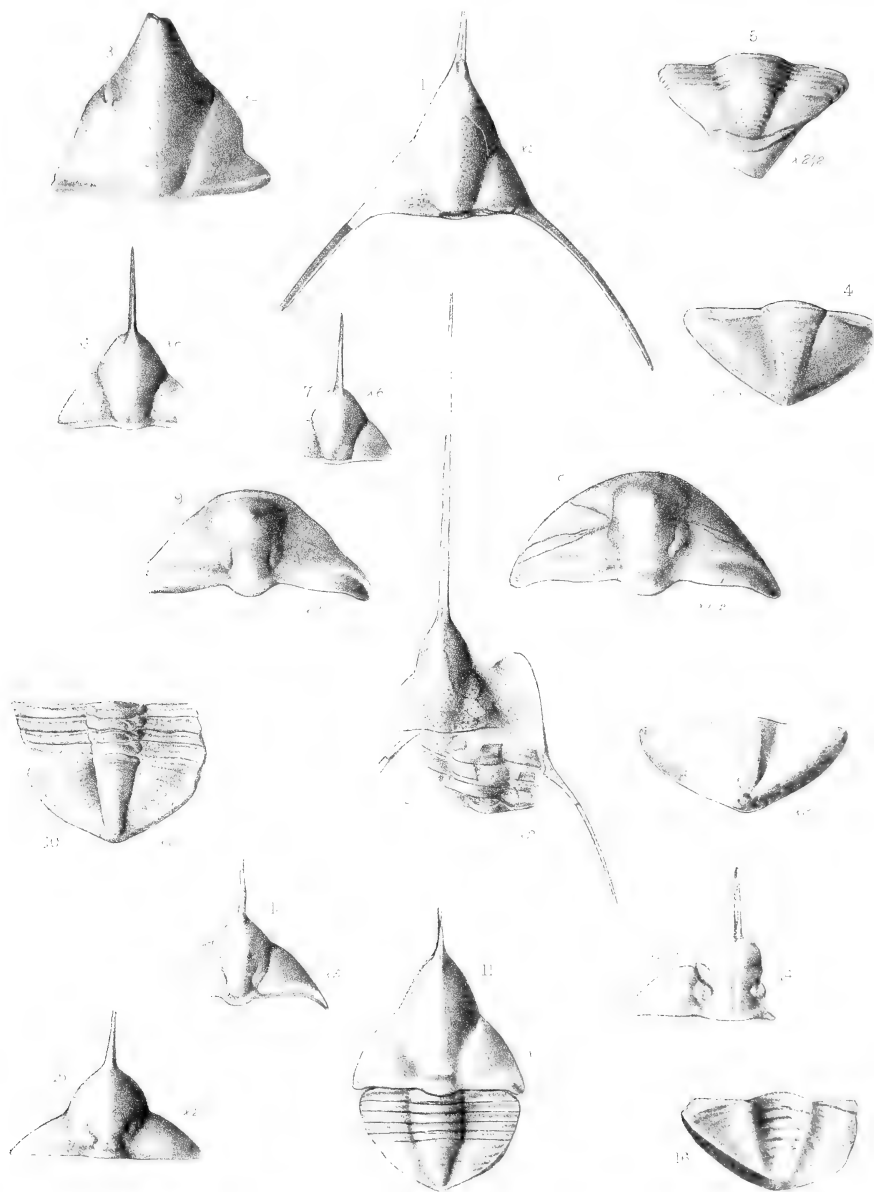


PLATE IV.

FIG.

PAGE.

Dionide lapworthi, Etheridge, jun., and Nicholson.

25.

1. Complete individual (flattened by pressure), showing all the specific characters. $\times 2$. Whitehouse. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' fasc. iii, pl. xx, fig. 1.)
2. Thorax and pygidium. $\times 3$. Whitehouse. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, *op. cit.*, pl. xx, fig. 3.)

Dionide richardsoni, sp. nov.

26.

3. Complete individual (except for points of genal spines). The apparent strong constriction of the glabella is due to imperfect preservation. $\times 2$. Whitehouse Bay. Mrs. Gray's Collection.
4. Nearly perfect individual, showing swollen bases of pleuræ and ornamentation. Glabella crushed. $\times 2\frac{1}{2}$. Thraive Glen. Mrs. Gray's Collection.
5. Ditto, showing cast of hypostome. $\times 3$. Thraive Glen. Mrs. Gray's Collection.
6. Imperfect specimen, showing much elongated genal spine. $\times 2$. Thraive Glen. Mrs. Gray's Collection.
7. Ditto. $\times 4$. Drummock Quarry. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, *op. cit.*, pl. vii, fig. 3, as *Phacops truncato-caudatus*, Portlock.)
8. Portion of head-shield, showing well-preserved glabella with base of median spine. $\times 3$. Thraive Glen. Mrs. Gray's Collection.

Apatokephalus, sp.

30.

9. Nearly perfect pygidium. $\times 5$. Balclatchie. Mrs. Gray's Collection.

Triarthrus becki (Green), var.

28.

10. Glabella and fixed cheeks, showing furrows and eye-lobes. $\times 5$. Balclatchie. Mrs. Gray's Collection.

Telephus fractus, Barrande.

44.

11. Imperfect specimen, showing neck-spine and eye-lobe. $\times 3$. Whitehouse Bay. Mrs. Gray's Collection.

Shumardia scotica, sp. nov.

42.

12. Well-preserved head-shield. $\times 9$. Whitehouse. Mrs. Gray's Collection.

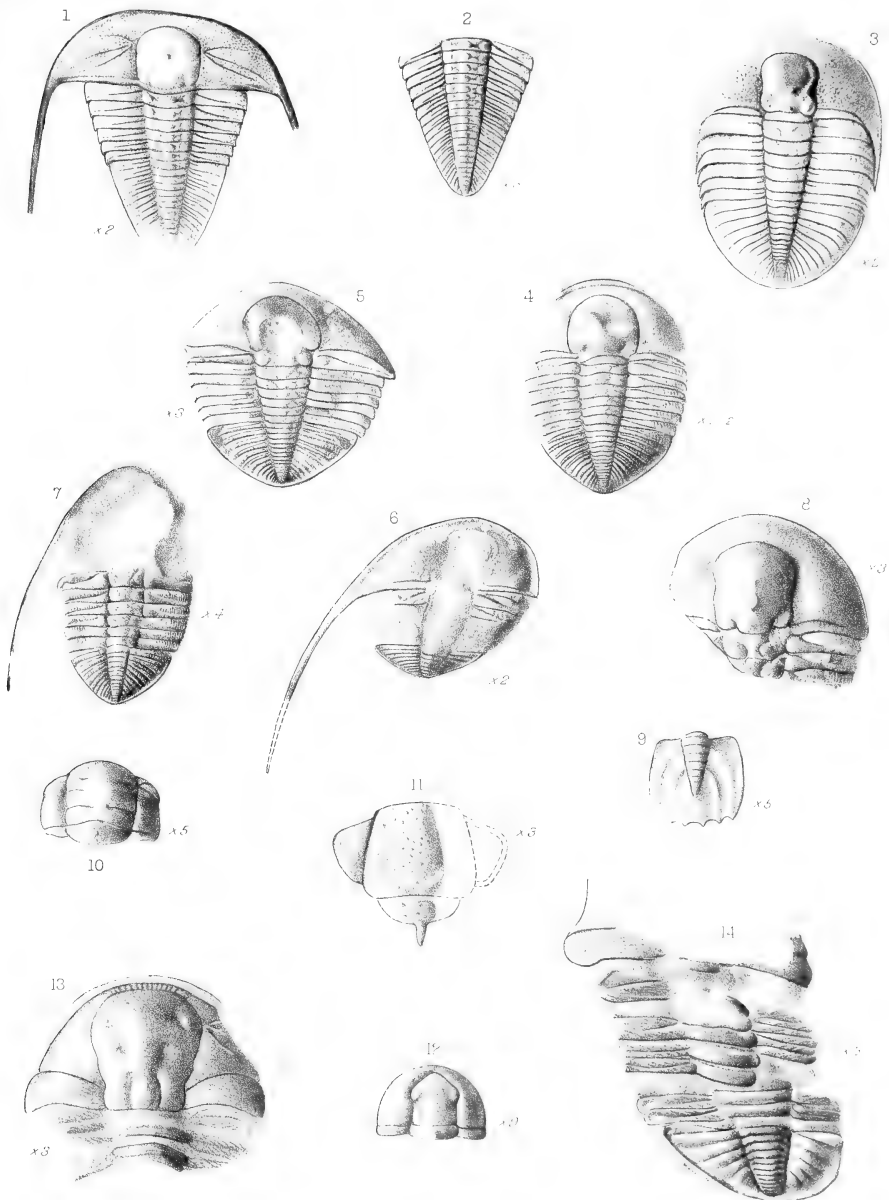
Salteria primæva, Wyv. Thomson.

43.

13. Head-shield with three thoracic segments attached. $\times 3$. Balclatchie. Mrs. Gray's Collection.
14. Crushed specimen, showing base of head-shield, thorax, and pygidium. $\times 4$. Balclatchie. Mrs. Gray's Collection.

Reed, Girvan Trilobites

PLATE IV.



G M Woodward del et lith.

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DIONIDE, TRIARTHURUS, APATOKEPHALUS, TELEPHUS. SHUMARDIA AND SALTERIA

PLATE V.

FIG.

PAGE.

Remopleurides barrandei, Etheridge, jun., and Nicholson.

31.

1. Head-shield, middle portion. $\times 4$. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. x, fig. 13.)
2. Ditto with expanded tongue. $\times 3$. Balclatchie. Mrs. Gray's Collection.
3. Ditto. $\times 8$. Balclatchie. Mrs. Gray's Collection.
4. Outline drawing of specimen in Hunterian Museum, Glasgow. $\times 3$. Balclatchie.

Remopleurides bicornis, sp. nov.

33.

5. Head-shield, nearly complete middle portion. $\times 3$. Dow Hill. Mrs. Gray's Collection.
6. Ditto. $\times 3$. Same locality and collection.
7. Ditto, showing the two frontal spines. $\times 3$. Same locality and collection.
8. Side view of impression of glabella, showing the frontal spines. $\times 3$. Same locality and collection.
9. Side view of cast of glabella. $\times 3$. Same locality and collection.
10. Head-shield, imperfect middle portion, with strong longitudinal grooves. $\times 3$. Same locality and collection.
11. Head-shield with one free cheek attached. $\times 3$. Same locality and collection.
12. Ditto. $\times 3$. Same locality and collection.
13. Free cheek, side view, showing eye. $\times 3$. Same locality and collection.
- 13*a*. Portion of eye of same specimen, showing lenses. $\times 10$.
14. Portion of thorax. $\times 3$. Same locality and collection.
15. One thoracic segment. $\times 3$. Same locality and collection.
16. Pygidium with one thoracic segment attached. $\times 5$. Same locality and collection.

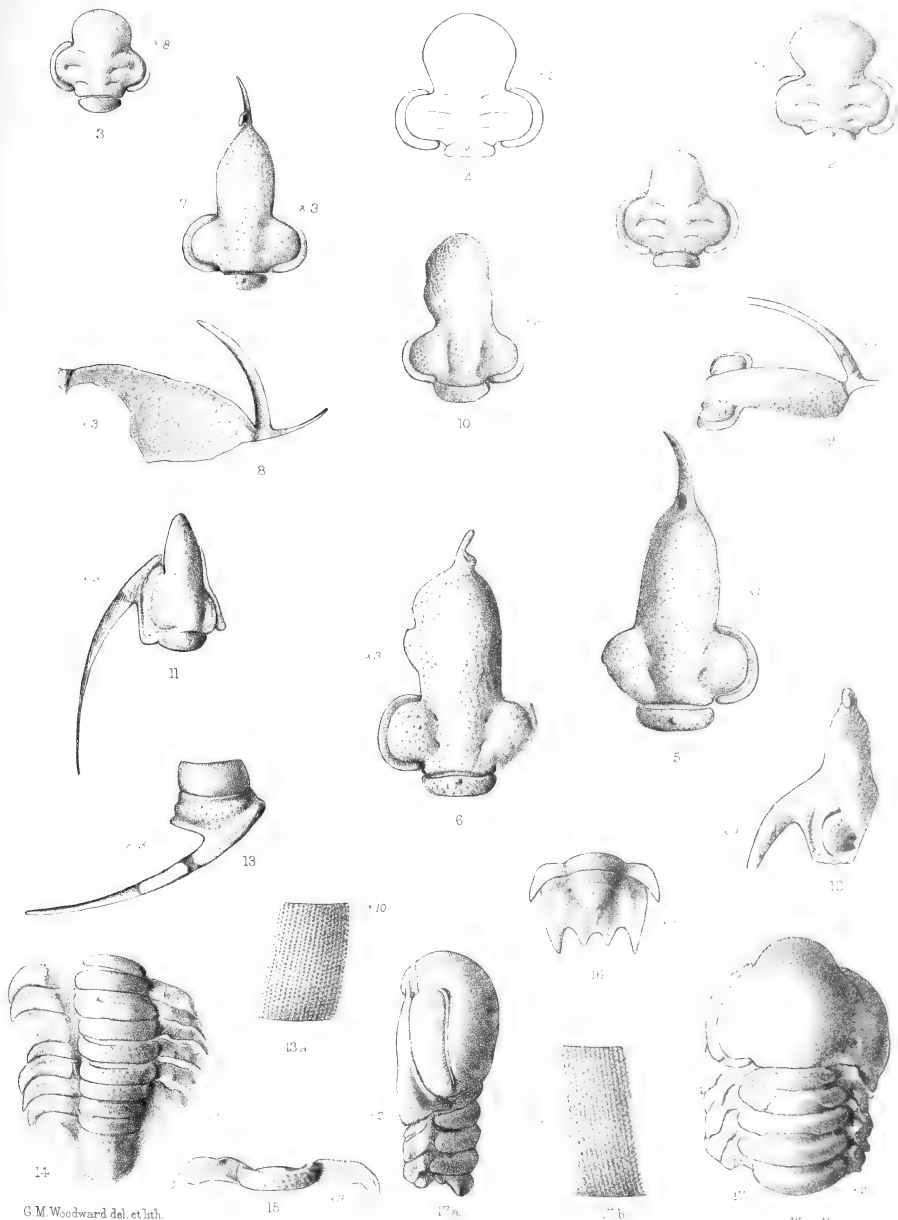
Remopleurides colbii, Portlock.

36.

17. Head-shield with portion of thorax attached. $\times 2$. Drummuck. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. x, figs. 8, 8*a*.)
- 17*a*. Side view of same specimen. $\times 2$.
- 17*b*. Portion of eye of same specimen, showing lenses. $\times 10$.

Reed, Girvan Trilobites.

PLATE V



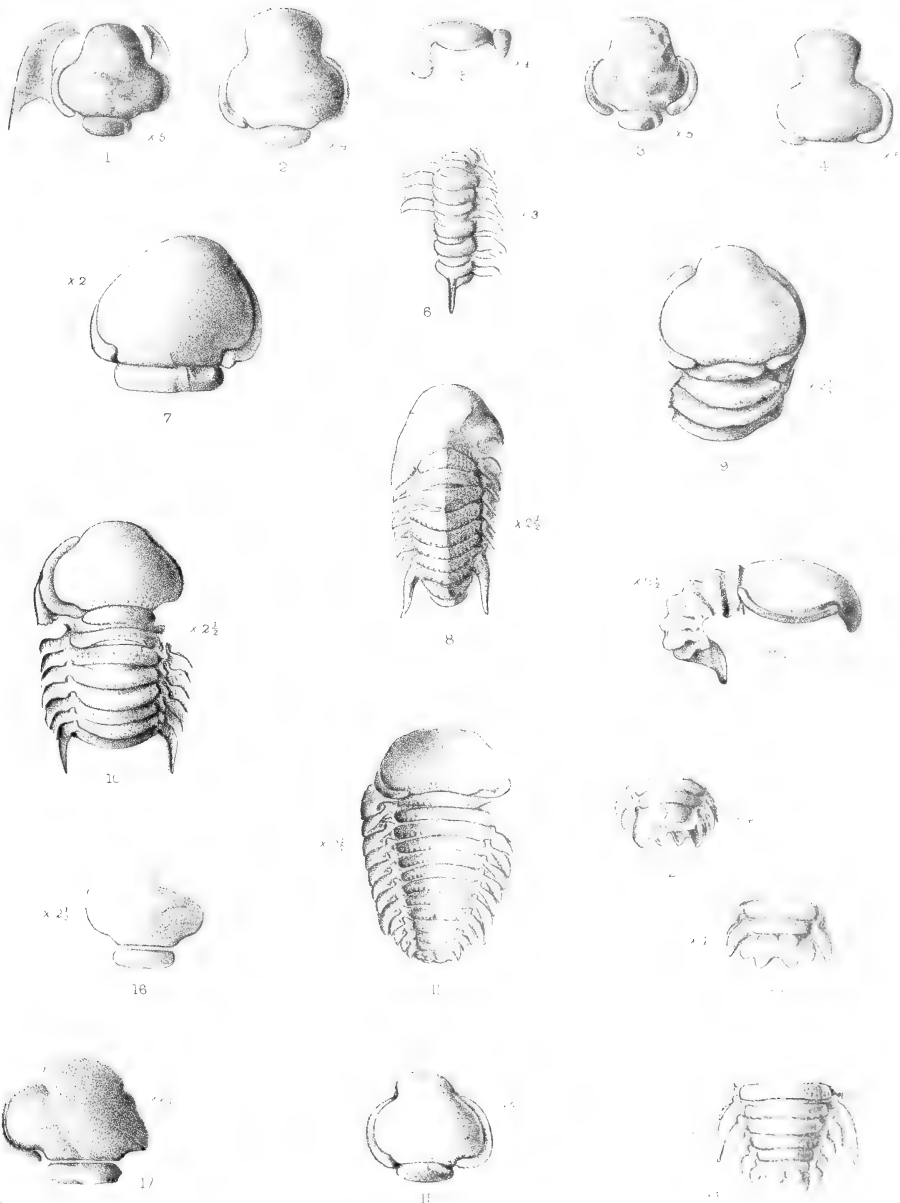
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REMOPLEURIDES.

PLATE VI.

FIG.		PAGE.
	Remopleurides correctus, sp. nov.	37.
1.	Head-shield, showing free cheeks and ornamentation. $\times 5$. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, 'Mon. Silur. Foss. Girvan,' pl. x, fig. 16, as <i>R. barrandei</i> .)	
2.	Ditto, without free cheeks. $\times 4$. Same locality and collection.	
3.	Ditto. $\times 5$. Same locality and collection.	
	Remopleurides correctus, var.	38.
4.	Head-shield, middle portion. $\times 5$. Dow Hill. Mrs. Gray's Collection.	
5.	Ditto, side view, showing tongue bent down. $\times 4$. Same locality and collection.	
	Remopleurides dorsospinifer, Portlock.	38.
6.	Portion of thorax, showing dorsal spine on eighth ring. $\times 3$. Dow Hill. Mrs. Gray's Collection.	
	Remopleurides longicostatus, Portlock.	39.
7.	Head-shield, middle portion. $\times 2$. Dow Hill. Mrs. Gray's Collection.	
	Remopleurides salteri, Reed, var. girvanensis, nov.	39.
8.	Nearly complete individual. $\times 2\frac{1}{2}$. Dow Hill. Mrs. Gray's Collection.	
9.	Portion of head-shield (showing two pairs of faint glabellar furrows) with part of thorax attached. $\times 2\frac{1}{2}$. Same locality and collection.	
9a.	Ditto, side view. $\times 2\frac{1}{2}$.	
10.	Head-shield and portion of thorax, showing impression of thoracic pleuræ. $\times 2\frac{1}{2}$. Same locality and collection.	
11.	Nearly complete individual, with pygidium attached. $\times 2\frac{1}{2}$. Same locality and collection.	
12.	Pygidium, with two thoracic segments attached. $\times 4$. Same locality and collection.	
13.	Pygidium, with two thoracic segments attached. $\times 4$. Ardmillan. Mrs. Gray's Collection.	
14.	Pygidium, with portion of thorax attached. $\times 4$. Same locality and collection.	
15.	Head-shield, middle portion, showing glabellar furrows. $\times 3$. Dow Hill. Mrs. Gray's Collection.	
	Remopleurides cf. nanus (Leuchtenberg).	41.
16.	Cast of glabella, showing three pairs of lateral furrows. $\times 2\frac{1}{2}$. Craighead. Mrs. Gray's Collection.	
17.	Glabella with shell preserved, showing the furrows faintly and punctuation of surface. $\times 2\frac{1}{2}$. Same locality and collection.	



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THE
PALÆONTOGRAPHICAL SOCIETY.

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A MONOGRAPH
OF
BRITISH GRAPTOLITES.

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PART III.

PAGES xxix—lii, 103—134; PLATES XIV—XIX.

[N.B.—The preceding Part, 1902, is wrongly numbered Part I.]

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1903.

1851. Bronn, in the 1851 edition of his 'Lethæa Geognostica,' enumerates twenty-seven species of Graptolites belonging to 'Lethæa Geognostica,' the genus *Graptolithus*, of which he asserts that twelve are vol. i. of Lower Silurian and fourteen of Upper Silurian age, while he records one species from the Bergkalk (Mountain Limestone). He gives figures of (1) *Gr. prionon*, (2) *Rastrites Linnæi*, and (3) *Retiolites Geinitzianus*, but these are all copied from Barrande.

1851. During the same year that witnessed the appearance of Boeck, Scharenberg's work (1851), a paper was published by Boeck, 'Bemærkninger angaaende Graptolitherne.' an author who, unlike Scharenberg, was not acquainted with Barrande's memoir. The illustrations of this paper are excellent, but the conclusions drawn from them are characterised by the same timidity of interpretation as that noticed in Scharenberg's paper; and, like many other writers at that time, Boeck attributed several characters, now known to be of specific value, to accidental deformation.

Classification.—This part of his paper is of little value. He considers that the *Prionotus scalaris* of Hisinger is the same as *D. pristis*; but none of the specimens figured by Boeck under these names are referable to either of these species as now defined. One of his forms, however, is easily identifiable from the excellent illustrations with *Climacog. Scharenbergi*, Lapw. (fig. 10). Under the title *Pr. sagittarius* he figures fragments of a form which may be a species of *Didymograptus*. Boeck's *Pr. folium* (fig. 27), which he considers to be identical with *Gr. foliaceus*, is possibly a *Phyllograptus*. *Gr. Murchisoni* (fig. 24) (or var. *geminus*) is well figured, but Boeck regards the branching in this species as an accidental structure, the result of splitting. One of the figures (fig. 30), which is supposed to represent *Gr. Murchisoni*, is apparently the species subsequently named by Lapworth *Bryograptus Kjerulfi*. Boeck considers that Schlotheim's *Orthoc. serratus* is identical with the *Pr. scalaris* of Hisinger.

Structure.—The structural features of the Graptolites are most carefully described and named by Boeck in this paper, though the connection and functions of these structures can hardly be said to have been fully realised by him. He considers that the skin or test of the Graptolite was partly elastic (or rather contractile). This test formed a kind of tube, which was prolonged into a narrow, pointed part—*apex*. The varying length of this apex was due to the fact that it was attached to an internal contractile organ, which could draw the apex back into the tube. The longitudinal dorsal groove ("suture" of Nicholson) he terms the *sulcus longitudinalis*, and this might be either straight, undulate, or angulate. The curious transverse grooves running from the angles from this sulcus in *C. Scharenbergi* he terms *sulci laterales*, while the grooves formed by the cell apertures themselves are named *sulci transversales*. The edges of these sulci (or costæ) are considered by him to be thickenings of the skin of the tube, and this thickening

increased "inwards inside the tube," and therefore was only discernible in compressed specimens. The thecal walls are noted and entitled *sulci obliqui*; but their continuations with the apertures were not observed by him. In addition he notices other structures, which he terms *septa longitudinales* and *transversales*.

Boeck did not consider that the outer skin had been anywhere provided with openings, but pointed out that the thickening observable at the base of the thecal walls had somewhat the appearance of such openings. He failed altogether to realise the meaning of his *sulci transversales*, which are the edges of the cell apertures. In various cross-sections of the polypary which he examined he recognised the fine thread-like part, *tendo* (virgula), "to which has been fastened contractile fibres, which could have effected the tube's shortening."

Affinities.—Boeck admits that practically nothing is known as respects the zoological affinities of the Graptolites. He naturally considers, however, that their structure, as above described, gives "reason for doubting the prevalent view of the time that the once living animals belonged to the family of Polyps, at least in so far as they have been placed among the living *Sertularia* and *Pennatula*," and he suggests that they might be "broken pieces of some tentacularly formed organ of a larger animal."

1851.

Harkness,

"Description of the
Graptolites found in
the Black Shales of
Dumfriesshire," Quart.
Journ. Geol. Soc.,
vol. vii.

Harkness in this paper gives a complete list of Graptolites obtained up to that date from the Moffat shales of South Scotland.

Twelve species are recorded, of which five are described as new forms. He arranges them under three generic types, adopting the classification of Barrande and M'Coy. 1. *Graptolites* (*Monoprion*). 2. *Diplograpsis* (*Diprion*). 3. *Rastrites*. All the species are described and figured. The previously recorded species included (1) *Rastrites peregrinus*, (2) *Gr. Sedgwickii*, (3) *Gr. Becki*, (4) *Gr. Nilssoni* (not the true *Mono. Nilsseni*, Barrande), (5) *Diplog. rectangularis*, (6) *D. folium*, (7) *D. foliaceus*. Five new species are described by Harkness, viz. (8) *Rastrites triangulatus*, (9) *Gr. Nicoli*, (10) *Gr. incisus* (11) *D. nodosus*, and (12) *D. pennatus*, but only the first two are identifiable with certainty at the present day.

As regards the zoological position of the Graptolites, Harkness considers that the *Diprions* are "not far removed from *Pennatula* and *Virgularia*," possessing in common with them a solid central axis, and a linear arrangement of cells. He asserts that the "existing analogies of *Graptolites* proper and *Rastrites* are not so well ascertained; but on the whole they appear not far removed from the modern genus *Sertularia*, and partake rather of the character of Hydroid than of Asteroid zoophytes."

1851.

Salter,

"Silurian Rocks of
Scotland," 'Quart.
Journ. Geol. Soc.,'
vol. vii.

1851.

Prout,

"Description of a New
Graptolite found in the
Lower Silurian Rocks
near the Falls of St.
Croix River," 'Amer.
Journ. of Science,'
vol. ii, ser. 2.

In the same year Salter, in an appendix to a paper by Murchison on "The Silurian Rocks of Scotland," described and figured two species of Graptolites, one of which was new, from the Girvan district, viz. (1) *Gr. tenuis* and (2) *Diplog. bullatus*. The figures, however, are not good, and it is difficult, if not impossible, to identify the species.

Two papers on Graptolites appeared in America during this year. Prout described and figured a new form of Graptolite under the name *Gr. Hallianus*. The drawings are poor, and it is difficult to identify the Graptolite, but it clearly belongs to the Dendroidea rather than to the Rhabdophora, and is probably a *Dendrograptus*.

Prout also discusses the zoological affinities of the Graptolites in some detail, and "with due deference to Beck" thinks that this new species, and all those with a hollow central tube and tubular cells, are allied rather to *Sertularia* than to *Virgularia*. For in the "Virgulariæ and Gorgonidæ the tubes of the polypi have no regular connection with the central axis, except through the medium of a fleshy or coriaceous envelope, and it would be difficult to account for the tubular character of both the polyparium and denticles of Graptolites, unless we suppose that the central or semi-calcareous stem was entirely destroyed, while the fleshy envelope remained in a perfect state of preservation, and this is extremely improbable." In other words, Prout considers that the skeleton of Graptolites was external, as in the Sertulariæ, rather than internal, as in the Gorgonidæ and Pennatulidæ. In his new form *Gr. Hallianus*, Prout recognises that there is no trace of a central axis, and this being very indestructible when present, probably therefore never existed. He believes that the "cup-like denticles" are "unilateral," "vaginated on their external sides," and "inserted into a common connecting tube." Prout considers that probably both the "Sertulariæ and Pennatulidæ existed at the same time in the ancient seas," and that some of the "differences of opinion on the origin of the Graptolites may be found more seeming than real."

1852.

Geinitz,

"Die Versteinerungen
der Grauwacke-
formation in Sachsen
und den angrenzenden
Länder Abtheilungen,"
Heft 1, 'Die Silurische
Formation,' "Die
Graptolithen."

The first edition of a general work by Geinitz appeared in 1852, entitled "Die Graptolithen." It resembles Barrande's memoir in its comprehensive character, but Geinitz's views on the structure, development, and zoological affinities of the Graptolites are little more than a repetition of those formulated by Barrande himself. Indeed, the work is critical and historical rather than original or suggestive. Geinitz differs from the views of Barrande, Suess, and Boeck, as to the direction of growth of the Graptolites, and consequently as to the proper position for figuring them. He

regards the narrow end as the "beginning of the animal," the apertures of the cell thus opening upwards, "facing the light." Some forms, such as *Monograpsus* and *Nereograpsus*, he holds to be free-swimming; while others, like *Diplograpsus* and *Cladograpsus*, were probably attached to the mud by their narrow end.

Affinities.—He adopts the generally accepted view as to the Sertularian affinities of the Graptolites, and disagrees with Boeck's views that they may be part of a larger animal, and therefore not complete in themselves. Geinitz attributes some of the various aspects under which the species present themselves to their flexibility and contractibility, and considers that *Pr. teretiusculus* possessed a greater elasticity and contractibility than any other known form.

Classification.—The classificatory part of Geinitz's work is perhaps the most valuable. He recognises five genera:

1. *Diplograpsus* (*Diprion* and *Petalolithus*). Geinitz holds that Barrande's name *Diprion*, being already in use for an insect, must be dropped, and as *Petalolithus* is identical with *Diprion*, that must be abandoned also. Further, McCoy's name of *Diplograpsus*, having the priority, should be adopted for the genus.

2. *Nereograpsus* (two-rowed Graptolites without or with a very slender axis). Geinitz emphatically states that these forms are not worm-markings, and that he has been able to recognise the openings of the polyp cells. Geinitz's views of these forms have, however, not been admitted by other palæontologists.

3. *Cladograpsus* ("two-armed or forked Graptolites"). Under this name Geinitz includes those species which are now grouped in the genera *Dicellograptus* (Hopkinson) and *Dicranograptus* (Hall).

4. *Monograpsus* (single-rowed Graptolites with solid axis). This name was proposed by Geinitz to include both the *Monoprion* and *Rastrites* of Barrande, and was suggested so as to be analogous to the *Diplograpsus* of McCoy. It has since been universally adopted.

5. *Retiolites* (double-rowed Graptolites, which are covered on their surface by a net-like skin, and possess a superficial central axis).

Geinitz points out that the name *Graptolithus*, or *Graptolithes*, can no longer be used for any single division of the Graptolites, any more than the family names Trilobite or Ammonite for a single genus of either of these families.

Description of Species.—The following species were described and figured by Geinitz, for the most part with great accuracy:—(1) *Diplograpsus ovatus*; (2) *D. folium*; (3) *D. pulvulus* (some of the figures represent *C. rectangularis*); (4) *D. pristis*, His. (which he believes to be identical with *Pr. scalaris*, His.); (5) *D. dentatus* (?) (fig. 25 undoubtedly represents the genus now known as *Dimorphograptus*, Lapworth); (6) *D. bicornis* (?); (7) *D. rectangularis* (?); (8) *D. bullatus* (?) (these three last forms Geinitz does not regard as true species); (9) *D. foliaceus*; (10) *D. cometa* (a new form subsequently chosen as the type of the sub-genus

Cephalograptus, Hopkinson); and (11) *D. teretiusculus*. Geinitz regards the three Graptolite forms *D. secalinus*, *D. laxus*, and *D. distichus* as doubtful species.

His genus *Cladograptus* is divided by him into two groups, for which, however, he did not suggest sub-generic titles. Those constituting his first group (*a*) are at present united in the genus *Dicranograptus*, Hall; those in his second group (*b*) are divided between *Dicellograptus*, Hopk., and *Didymograptus*, Hall. His first group contained Hall's species of (12) *Cladograptus ramosus* and (13) *C. furcatus*. In the second group are included a new species, (14) *C. Forchhammeri*, and the previously described forms (15) *C. Murchisoni*, (16) *C. serra*, (17) *C. sextans*, and (18) *C. serratulus*.

Under *Monograptus* the following are figured and described:—(19) *Monograptus sagittarius*, (20) *M. Barrandeii*, (21) *M. mutinus* (under this name are included some scalariform views of a *Climacograptus*), (22) *M. tectus*, (23) *M. Nilssoni*, (24) *M. bohemicus*, (25) *M. incisus*, (26) *M. virgulatus*, (27) *M. colonus*, (28) *M. latus* (= *M. Roemeri*), (29) *M. chimæra*, (30) *M. testis*, (31) *M. Sedgwickii*, (32) *M. Halli*, (33) *M. distans*, (34) *M. Becki*, (35) *M. Nicoli*, (36) *M. priodon*, (37) *M. millepeda*, (38) *M. proteus*, (39) *M. convolutus*, (40) *M. turriculatus*, (41) *M. triangulatus*, (42) *M. gemmatus*, (43) *M. peregrinus*, (44) *M. Linnei*, and two new forms, (45) *M. Heubneri* and (46) *M. Salteri*.

Geinitz enters fully into the discussion of the structure of *Retiolites*, and gives his support to the views of Barrande rather than to those of Suess.

Distribution.—An important section of Geinitz's work is devoted to the general distribution and range of the Graptolites, but little or no advance is made on the facts and conclusions previously given by Barrande and others.

A short paper by Salter appeared in the same year. In this a few species of Graptolites obtained by Harkness from the South of Scotland are figured and described. Under the name (1) *D. teretiusculus*, some specimens of *Climacograptus* are figured, one of these being certainly referable to *C. Scharenbergi* (Lapw.); (2) *Gr. Flemingii* is described as a new species, and a form referred to (3) *Gr. sagittarius* is figured; but *Gr. laxus*, *Gr. Nicoli* and *Gr. tænia*, Salter, are not considered by the writer to be distinct species.

As regards the range of the Graptolites, Salter says that "there is no evidence of a double Graptolite being found above the Caradoc Sandstone" ("Llandovery" of modern geologists).

Hall, in the second volume of his 'Palæontology of New York,' figures and describes the two species (1) *Gr. clintonensis* and (2) *Gr. venosus* from the Clinton beds, previously named by him in 1843 and 1849. The former is a *Monograptus*, allied to *M. riccartonensis*, the latter a *Retiolites*,

1852.

Hall,

'Palæontology of New
York,' vol. ii.

1852.

Salter,

"Description of some
Graptolites from the
Silurian of Scotland,"
'Quart. Journ. Geol.
Soc.,' vol. viii.

similar to or identical with *R. Geinitzianus*. He also gives a diagnosis of the new genus **Dictyonema**, from which it will be seen that he was as yet uncertain as to the zoological affinities of this form. He writes, "The general structure of this coral is very similar to *Penestella*. The branches consist of a black film enveloping a semi-calcareous or corneous interior, and they have the appearance and texture of Graptolites, to which they are doubtless closely allied." It has very little, if any, true relation with *Gorgonia*, to which it was previously referred; it "possesses no positive characters by which it can be identified, either as Bryozoa or true corals." Two new species of this genus are described and figured by him—(3) *D. gracilis* and (4) *D. retiformis*. He found also a specimen of a new genus **Inocaulis**, which is, however, probably not a Graptolite.

1852.

Barrande,
"Einige Bemerkungen
über die Abhandlung
des Suess," 'Jahrb. der
k. k. Geol. Reichsan-
stalt.'

In the same year (1852) Barrande replied to the observations and conclusions made by Suess on "The Bohemian Graptolites."

As regards *Retiolites*, Barrande refuses to accept Suess' interpretation of its structure, believing that the apparent facts observed were due to the bad state of preservation of the specimens. He argues strongly against the validity of Suess' genus *Petalolithus*, and his species *Ret. grandis*, *Petalog. parallelocostatus*, *Gr. ferrugineus*, *Gr. dubius*, *Gr. lævis*, *Gr. falc.*, *Gr. armatus*, and *Gr. Barrandei*. Subsequent investigators agree with Barrande in most of these contentions.

1853.

Salter,
"Description of a New
Species of Graptolite,"
'Quart. Journ. Geol.
Soc.' vol. ix.

A new Graptolite species was described in 1853 by Salter, from the Hudson River group at Lauzon Precipice, under the name *Gr. caduceus*. Two species, however, are actually figured by him under this name, the one being *Tetragraptus serva* of Brongniart, and the other the *Didymog. gibberulus* of Nicholson.

1853.

Ribeiro,
"On the Carboniferous
and Silurian Forma-
tions of the Neighbour-
hood of Bussaco,"
'Quart. Journ. Geol.
Soc.' vol. ix.

In 1853 Ribeiro recorded *Gr. ludensis* of Murchison from the upper division of the Silurian of Portugal, probably from the rocks corresponding with those of the Wenlock formation of England.

1853.

Richter,
"Thüringische Graptol-
ithen," 'Zeit. d.
Deutsch. Geol. Gesell.'
Bd. v.

A third paper by Richter on "Thüringische Graptolithen" was published in 1853. In this paper he proposes the following classification of the Graptolites, which is considerably more detailed than the one previously given by him in 1850.

- (A) Graptolites with many axes. *Cladograpsus*.
 (A) Many-celled. ? (1) *Cl. nereitarum*.
 (v) One-celled. ? *Lophoclenium comosum*.
- (B) Graptolites with one axis.
 (A) Many-celled.
 (1) Axis weak. *Nereograpsus* (Geinitz).
 (2) *N. Sedgwicki*; (3) *N. Beyrichi*, *N. MacLeayi*.
 (2) Axis strong.
 (a) Skeleton net-like. *Retiolites*, Barr.; (4) *R. rete* (?).
 (b) Skeleton complete. *Diplograpsus*.
 (aa) Cells overlapping.
 D. ovatus, *D. folium*, (5) *D. palmatus*, *D. pristis*, *D. dentatus*,
 (6) *D. terebinthus*.
 (bb) Cells free.
 (7) *D. birastrites* (= *D. acuminatus*), (8) *D. cometa*.
 (v) One-celled. *Monograpsus*, Geinitz.
 (1) Cells in contact.
 M. testis, (9) *M. nutius* (? *M. Roemeri*), *M. column*, (10) *M. sagittarius*,
 (11) *M. Nilssoni*, *M. Halli*, *M. Sedgwickii*, *M. Heubneri*,
 (12) *M. priodon*, (13) *M. Becki*, *M. convolutus*, (14) *M. turriculatus*,
 M. proteus, *M. millepeda*, (15) *M. pectinatus*.
 (2) Cells free.
 M. triangulatus, (16) *M. peregrinus*, (17) *M. spina* (?), (18)
 M. urceolus (?), *M. Linnæi*, (19) *M. gemmatus*.

It will be seen, therefore, that Richter adopted the various genera recognised by Geinitz, even including those now referred to worm burrows. Most of the species of Graptolites mentioned are described and figured by Richter, and the drawings are fair; but hardly any of his five new forms, viz. *Retiolites rete*, *D. birastrites*, *M. pectinatus*, *M. urceolus*, and *M. spina*, are recognised as distinct species at the present day.

Structure.—Richter did not advance our knowledge much as regards the structure of the Graptolites, but he pointed out more clearly than had previously been done those characters of the cells which are of specific value, such as (1) the general form, (2) the relative distance, (3) the shape, (4) the inclination, etc. Not only so, but in this memoir Richter makes many original suggestions of considerable importance respecting the development of the Graptolites. He was the first to suggest that the "foot" might have had some connection with the development of the Graptolite; but he does not enter into any details. He points out that the greatest amount of growth is in the direction of length; the circumference once attained does not increase, and the lowest cells are always the shortest (except in

¹ NOTE.—In this and all subsequent papers only the species figured are numbered.

Diplog. cometa). The distance apart of the cells is the same throughout, but the shorter and thinner lower cells appear to be more distant, because they do not overlap so much. In his drawings of *Diplog. palmeus*, Richter figures two aspects of the polypary ("dorsal and ventral"), and shows that the medium septum is incomplete. A similar structure is visible in his figures of *Diplog. cometa*.

Another most important point first brought out by Richter in this paper is that development among the Graptolites is in the direction of simplification of the general forms. Thus the many-branched forms of the earlier formations gave place in the newer formations to those with two rows of cells, and these in their turn to those with one row of overlapping cells, and eventually to those with free cells.

Mode of Existence.—As regards their occurrence and mode of existence, Richter appeared to be of the opinion that the Graptolites lived attached by the "foot" to the floor of the ocean. Owing to their large size, they were probably not short-lived, and they must have lived in enormous colonies to account for the numbers found in the rocks. They are seldom found in association with other animals. Richter observes that the forms with overlapping cells occur isolated, or in association with other species, whereas the free-celled forms are found in groups of their own kind. He suggests that this might be due to their greater or smaller power of moving from place to place. All the Graptolites mentioned by Richter in his paper occur in the Alum and Siliceous shales of Thüringia.

1854.

Fournet,
"Sur les terrains-
anciens de Neffiez,
Languedoc," 'Bull. de
la Soc. Géol. de France,'
ser. 2, vol. xi.

The papers which appeared during the next few years are of little importance, and are mainly stratigraphical in their bearing. Fournet simply states that Graptolites occur in limestones and shales associated with *Cardiola interrupta*, but records no species.

1854.

Beyrich,
"Ueber das Vorkom-
men von Graptolithen
im Schlesi-schen
Gebirge," 'Zeit. d.
Deut. geol. Gesell.,'
vol. vi.

Beyrich, in his paper "Ueber das Vorkommen von Graptolithen im Schlesi-schen Gebirge," mentions no definite Graptolite species.

1854.

McCoy,
'Description of the
British Palæozoic
Fossils in the Geo-
logical Museum of
Cambridge.'

In his 'Description of the British Palæozoic Fossils in the Geological Museum of Cambridge,' McCoy gives a description of a few species of Graptolites, some of which also are figured. *Gr. convolutus*, (1) *Gr. latus*, (2) *Gr. lobiferus*, *Gr. bulensis* and var. **minor** (a new variety), (3) *Gr. millepeda*, *Gr. Murchisoni*, *Gr. sagittarius*, (4) *Gr. Sedgwickii*, (5) *Gr. tenuis*, *Diplog. foliaceus*, *D. folium*, *D. mucronatus*, *D. pristis*, var. *B.*, *D. ramosus*, (6) *D. rectangularis*, *Diplograpsus* (?) *sextans*.

Although McCoy places the dichotomously branching forms provisionally in the genus *Diplograpsus*, he points out that they constitute a “peculiar little group;” and he suggests that if necessary they might be called **Didymograpsus** = twin Graptolites. This generic name is now in general use for a certain section of these two-branched forms, namely, for those which have their simple, sub-cylindrical, tube-like cells on the inner margin.

1854.
Murchison,
‘Siluria.’

In the second edition of Murchison’s ‘Siluria,’ published in 1854, a brief description of four genera of Graptolites, viz. *Diplograpsus*, *Graptolites*, *Rastrites*, and *Didymograpsus*, is given, with figures of a few of the most characteristic species

in illustration.

Murchison does not commit himself to any opinion as to the zoological affinities of the Graptolites, but merely points out that they have been supposed by some to be nearly allied to Virgularia, the Corallines or Sertularia, and he considers that they “grew on the fine mud at the bottom of the sea.”

As regards their geological range, he asserts that they are exclusively Silurian, and that in Britain neither *Diplograpsus* nor *Didymograpsus* are “ever met with above the horizon of the Caradoc sandstone;” in Bohemia, however, the double-celled *Diplograpsus* occurs in association with the single-celled form *Graptolites*.

1855.
Harkness,
“Anthracitic Schists
and Fucoidal Remains
in the Lower Silurian
Rocks of the South of
Scotland,” ‘Quart.
Journ. Geol. Soc.’
vol. xi.

In the year 1855 Professor R. Harkness described but did not figure a new species of Graptolite under the name **Rastrites Barrandi**, from the Glenkiln shales of the Moffat country. Judging from his description, this may have been a form of *Thamnograptus*. Many Graptolite species are recorded by him in this paper from various localities in South Scotland, including *Gr. sagittarius*, *Diplog. pristis*, *D. ramosus*, *D. mucronatus*, and *D. bicornis*, *D. folium*, *Gr. Sedgwickii*, *R. peregrinus*, and *R. Linnei*.

In the light of recent opinion as to the mode of life of the Graptolites, it is interesting to note that Harkness makes the same suggestion as that already made by Suess (1851); viz. that the carbonaceous matter of the anthracite shales has not been derived from the Graptolites themselves, but is “due to the existence of seaweeds during the earlier portion of the Lower Silurian epoch.”

1855.
Cassiano de Prado,
“Sur la géologie
d’Almaden d’une
partie de la Sierra
Morena and des
Montagnes de Toledo,”
‘Bull. de la Soc. géol.
de France,’ vol. xii.

In the same year Cassiano de Prado recorded *Gr. spiralis*, *Gr. Halli*, *Gr. priodon*, and *Gr. palmens* from the Silurian rocks of Almadá, the Sierra Morena and Toledo.

1855.
Roemer,
"Graptolithen am
Harz," 'Neues
Jahrbuch,' vol. vii.
The German palæontologist, Roemer, described and figured eight species of *Monograptus* from the Harz region, namely, the (1) *M. priodon*, (2) *M. latus*, (3) *M. sagittarius*, (4) *M. proteus* of earlier observers, and four new forms, viz. (5) *M. Jüngsti*, (6) *M. polyodonta*, (7) *M. oblique-truncatus*, and (8) *M. sub-dentatus*; but his drawings are so poor that it is impossible to identify the species. His form *M. sub-dentatus* is, however, probably the same as the *M. dubius* of Suess.

1855.
Emmons,
'American Geology,'
vol. i.
A number of American species of Graptolites and some new genera were described and figured by Emmons in his 'American Geology,' in 1855. These include (1) *Diplograptus secalinus* (= *Fucoides simplex*, Emm.), (2) *D. rugosus*, (3) *D. dissimilaris* (= *Climacograptus* fragment), (4) *D. ciliatus*, (5) *D. obliquus*, (6) *Monograptus elegans* (= probably a fragment of a Dichograptid), and (7) *M. rectus*. The first new generic name proposed by him is **Cladograptus**, for Graptolites bearing "serrations or cells arranged on the outer edges of a branching stipe, axis none." This genus is held to embrace two new species, viz. (8) *C. dissimilaris*, and (9) *C. inequalis*. These species, however, certainly belong to the genus *Dicranograptus*; and as the generic name *Cladograptus* had already been employed by Geinitz, Emmons' title never came into use.

The second new genus proposed by Emmons is, however, generally accepted at the present day. This is named **Glossograptus**, with his *G. ciliatus* as its type. He suggests that probably his own species *Diplog. ciliatus* and *D. crinitus* may belong to this genus. Emmons lays great stress on the existence of the free solid axis extended beyond the body of the stipe in *Glossog. ciliatus*, and believes that it may have "served to attach the Graptolite to other objects;" or else the animal may have floated freely in the sea. The first of these views of Emmons has received much support from the recent discoveries of Ruedemann.

Emmons' third genus, **Staurograptus**, with its type species (11) *S. dichotomus*, is evidently founded upon the proximal part of a *Dichograptid*, with only four branches showing clearly, and the generic name has never come into use.

His fourth genus, **Nemagraptus**, is suggested for forms having an "axis elongated and thread-like, simple or compound branches round at the base, and flattened at their extremities, with cells which appear to be arranged on the flattened part of the axis instead of the margins." Of the two examples, viz. (12) *N. elegans* and (13) *N. capillaris*, described by Emmons, the former is clearly a fragment of the form subsequently described and figured by Hall as his *Graptolithus gracilis*, and afterwards made by him the type of his genus *Canograptus*.

Emmons' descriptions of all his species are meagre in the extreme, and his figures so poor that it is very difficult to identify the forms. All the species

described by him came from the so-called Taconic beds of New Hampshire, from strata now known to be of Ordovician age.

The only work that appeared in 1856 in which Graptolites were referred to was Bronn's '*Lethæa Geognostica*.' The reference to these fossils in this book is almost entirely a *résumé* of the work of previous observers, and contains little or nothing that is original. He accepts Barrande's three genera of *Monoprion*, *Rastrites* and *Retiolites*, but rejects Geinitz's *Cladograpsus* and *Nereograpsus*. These he considers to be trails or footprints of annelids.

As regards the affinities of the Graptolites, Bronn is opposed to Barrande's view of their relationship to the Pennatulidæ, on account of their very different habit, and also from the fact that the family of the Pennatulidæ is not represented in any of the Palæozoic formations.

A few Graptolites were figured in 1857, in the second edition of Naumann's '*Lehrbuch der Geognosie*;' but the author adds nothing new, and the few figures that are given are mainly copies of those of Barrande.

In 1857 McCrady published a paper on the "Zoological Affinities of Graptolites," in which he endeavoured to show the similarity of the graptolitic forms to the Echinoderm larvæ. (We have not, however, been able to obtain access to this paper.)

Descriptions and figures of the Graptolites of the Island of Sardinia were published by Meneghini in 1857. Nine species are named, and of these seven are described as new. Unfortunately the accompanying illustrations are so poor that it is impossible to identify any of the specific forms with certainty; and in spite of Meneghini's lengthy descriptions, his suggested names have never been adopted. It is possible, however, that his figures are attempts to represent well-known species. His (1) *Gr. (Monograpsus) antennularis* is of the *M. Becki* type, and his (2) *Gr. Larmarmoræ* is possibly identical with Salter's *M. Flemingii*. The form entitled (3) *Gr. colonus*, Barrande, is wrongly identified; but (4) *Gr. belophorus* may be that species. His (5) *Gr. hemipristis* is represented by views partially scalariform, and is therefore unidentifiable. His (6) *Gr. Gonii* belongs clearly to the *M. comericus* group. His (7) *Gr. falcatus* resembles the *M. limatulus* of Törnquist in general form and in the long proximal prolongation of the stipe. His (8) *Gr. mutuliferus* is of the type of *M. Flemingii*; while his (9) *Gr. priodon* is perhaps correctly referred to Bronn's species, but even this is uncertain. His list is closed by two unnamed species of *Diplograpsus*, which are

not specifically recognisable. But while his figures do not admit of the recognition of the individual species, the general habit is fairly well given, and it is evident that nearly all the forms are of Wenlock age.

In the same year Salter described a new genus of Graptolite, which he called **Graptopora**, and he considered this to be intermediate in character between a Graptolite and a *Fenestella*. The species which he regarded as typical of the genus was his own *Graptopora* (*Fenestella*) *socialis*. This genus had already been described by Hall under the title of *Dictyonema*.

In a paper entitled "Notes upon the Genus *Graptolithus*," in 1859—a part of which paper had been communicated to Sir William Logan in 1857 ('Report of Progress, Geol. Survey of Canada'),—Hall criticises to some extent the views expressed by Barrande in his 'Graptolites de Bohême,' and by other European graptolithologists. It is interesting to note that the two greatest palæontologists of that day, living on opposite sides of the Atlantic, had totally different graptolitic material to work upon. Hall's examples of Graptolites were practically all branching forms from Lower Silurian (Ordovician beds), while Barrande's were all simple forms of Upper Silurian age. This was a disadvantage to them in the interpretation of their results at the time, but it was nevertheless extremely fortunate for the progress of science, for owing to this circumstance both the Lower and Upper Silurian Graptolitic faunas were worked out independently by these two great palæontologists, neither being biassed by the views of the other.

Hall was unwilling to accept the European genera, *Monograpsus*, *Diplograpsus*, and *Cladograpsus*, believing that there was not sufficient reason at that time for separating branching forms from the unbranched, and regarding all those with a single series of serratures as having been originally composed of two, four, or more branches. He also rejects Geinitz's genus *Nereograpsus*. He states that the Canadian specimens "sustain the opinion already expressed that *Dictyonema* will form a new genus of Graptolites, the serratures being on the inner side;" while as regards the form of the polypary in this genus, he concludes that while its mode of growth was "probably flabelliform in some species, it is clearly funnel-shaped in *D. retiformis*."

Many new species are described by Hall in this work and partly figured, the majority being grouped under the single generic name of *Graptolithus*. These embrace (1) *Gr. logani* and (2) *Gr. abnormis* (now placed in the genus *Loganograptus*), and (3) *Gr. flexilis* (*Clonograptus*). Hall's specimens of *Loganograptus logani* show the presence of a disc for the first time in the history of graptolitic research.

The remaining forms, all of which were new to science, are (4) *Gr. octobrachiatus*, (5) *Gr. oetonarius* (*Dichograptus*); (6) *Gr. quadribrahiatus*, (7) *Gr. crucifer*, (8) *Gr. bryonoides*, (9) *Gr. Headi*, (10) *Gr. alatus*, (11) *Gr. fruticosus*, (12) *Gr. denticulatus* (*Tetragraptus*); (13) *Gr. indentus*, (14) *Gr. nitidus*, (15) *Gr. bifidus*, (16) *Gr. patulus*, (17) *Gr. similis*, (18) *Gr. extensus* (*Didymograptus*); (19) *Gr. pristiniiformis* (*Diplograptus*); (20) *Gr. ensiformis* (*Retiolites*, Hall); (21) *Gr. tentaculatus* (*Retiograptus*, Hall).

In addition to these, Hall describes three species of a remarkable four-rowed type, viz. (22) *P. typus*, (23) *P. ilicifolius*, and (24) *P. angustifolius*. For these he suggests the new generic name of **Phyllograptus**. He explains the structure of these forms, and shows that they consist of "four semi-elliptical parts joined at their straight sides."

Hall was well aware that the exact number of branches did not constitute either a generic or specific character in some of his new forms, for he notices a specimen of *Gr. octobrachiatus* with only seven branches, and a *Gr. Loganii* with nine.

The genera *Thamnograptus* and *Dendrograptus*¹ are briefly referred to, and he also describes a new genus which he calls **Plumulina**, of which he gives two species, (25) *P. plumaria* and (26) *P. gracilis*.

Hall also figures some Graptolite stipes with reproductive cells. As the question of the reproduction of the Graptolites is entered into in greater detail by Hall in his 'Graptolites of the Quebec Group' (1865), the discussion of his results will be referred to later.

He disagrees with Barrande's view that the narrower end is the newest part of the polypary, and shows that the origin of the stipe in some of the Canadian forms renders this untenable. In other respects he does not add much to our knowledge of the structure of the Graptolites. Referring to those forms which have cells on two sides (*Diplograptus*), he is "disposed to believe that they may have been simple from the base," though the bifurcated appearance of *D. bicornis* offers objection to this view.

As regards the mode of life of the Graptolites, Hall is somewhat in favour of the theory of their having been free floating animals; for, as he points out, "in many specimens there is no evidence of a point of attachment or radix, and they have much the appearance of bodies floating free in the ocean."

He notes how strongly the Graptolites simulate the Palaeozoic Bryozoa in mode of growth, though they differ essentially from all of them, not only in form, but in the arrangement of their cellules, in the nature of their substance, and in the structure of their skeleton.

¹ The actual description of *Thamnograptus* was not published until 1859 (Pal. New York, vol. iii, Suppl.). *Dendrograptus*, though named in 1857, does not seem to have been fully described until 1865 (Graps. of Quebec Group).

1858-9.

Carruthers,
 "On the Graptolites
 from the Silurian
 Shales of Dumfries-
 shire, with a Descrip-
 tion of three new
 Species," 'Ann. Mag.
 Nat. Hist.,' ser. 3,
 vol. iii.

Carruthers' first paper on the Graptolites appeared in 1858 in the 'Transactions of the Royal Physical Society of Edinburgh.' It was, however, republished in 1859 in the 'Annals and Magazine of Natural History.' It contains a description of three new species from the Silurian shales of Dumfriesshire, viz. (1) *Cladograpsus* (*Pleurograptus*) **linearis**, (2) *Diplograpsus* (*Cryptograptus*) **tricornis**, and (3) *Didymograpsus* (*Dicellograptus*) **Moffatensis**. Carruthers suggests the generic title of *Cladograpsus* for forms "having two main stems each supporting the cells on their upper sides," and with "branches given off at irregular distances." This name, as we have already seen, had been employed by Geinitz and Emmons for forms generically distinct from those for which it was proposed by Carruthers.

1859.

Giebel,
 "Die Silurische Fauna
 des Unterharzes,"
 'Zeit. für die Gesamte.
 Natur. Wiss.,' vol. xi.

In the year 1859 also Giebel recorded *Monog. sagittarius* from the Silurian beds of the Lower Harz.

1859.

Hall,
 Supplement to vol. i,
 'Palæontology of New
 York,' vol. iii.

In 1859, in a supplement to vol. i of his 'Palæontology of New York' (which supplement was, however, actually published simultaneously with vol. iii), the preceding "Notes" were reproduced by Hall, and some additional new forms from the Hudson River group were figured and described.

These include (1) *Gr. multifasciatus* (a many branched form, *Amphigraptus*); (2) *Gr. divaricatus* (*Dicellograptus*); (3) *Gr. gracilis* (*Cænograptus*, Hall); (4) *Gr. marcidus* (*Cryptograptus*); (5) *Gr. Whitfieldi*, (6) *Gr. angustifolius* (*Diplograptus*); (7) *Gr. spinulosus* (*Glossograptus*); (8) *Retiograptus Geinitzianus* (*Clathrograptus*); (9) *Thamnograptus typus* and (10) *T. capillaris*, (11) *Rastrites Barrandi* (? *Thamno-*
graptus).

As regards the points of structure brought out in the examination and description of these species, Hall remarks that in *Thamnograptus* the cellules are at present unknown. In *Gr. divaricatus* he calls attention to a row of small *nodes* placed obliquely to the direction of the axis. He figures a large specimen of *Gr. gracilis*, and traces the stages in development from the earliest, in which there are no lateral branches, through the form now referred to *Nemag.* (*Cænog.*) *circularis*, up to the large and typical form. He notices the radicle or axillary bar from which the main stipes diverge, and writes that "it is barely possible that the apparent central radicle may be the remains of two other stipes, corresponding to the two usually preserved." He argues that it is "still possible that these small bifurcate fronds are but the separated offshoots from a rhizoma, which extended

along the muddy bottom of the sea, giving off the ascending stipes in pairs, which in their progress become branched, as before shown; and in this case the little transverse bar in the bending of the frond is a part of the broken rhizoma."

1859.

Goeppert,

'Die Fossile Flora der Silurischen, Devonischen, und unteren Kohlen-formation des sogenannten Uebergangsgebirges.'

Although the Hydroid nature of the Graptolites would seem to have been well established by this time, Goeppert, in 1859, rejected the generally accepted view, and asserted that they were algæ. He figures part of a Graptolite branch, apparently bearing a fruit like that in *Callithamnium*, as a direct proof of their true algal nature. Goeppert figures many forms of true Dendroid Graptolites, to most of which he gives names corresponding to those usually given to algæ.

Thus his (1) **Sphærococcites Scharyanus** is a *Callograptus*; his (2) **Calithamnites Reussianus** is a good *Ptilograptus*; while (3) **Chondrites fruticulosus** and (4) var. **articulatus** are probably *Dendrograpti*. He retains the generic name *Dictyonema* of Hall, but diagnoses it as an alga, and substitutes the specific name (5) *Dictyonema Hisingeri* as a common title for *Gorgonia flabelliformis*, Eich., *Fenestella socialis*, Salt., and *Dicty. fenestratum*, Hall, which he held to be the same species. He agrees with Brongniart in regarding *Fucoides dentatus* and *F. serræ* as algæ, though he admits that the former also resembles Graptolites; but he changes the generic name of both to **Amansites**. Goeppert's drawings are good for the most part, and the paper is of value on this account.

1860.

Hall,

13th Report of the State Cabinet.

Two papers on Graptolites were published in America during the year 1860, one by Hall and one by Dawson. The paper by Hall was merely a repetition of that published by him in the previous year in the 'Palæontology of New York.'

1860.

Dawson,

"Note on the Silurian and Devonian Rocks of Nova Scotia," 'Canad. Naturalist and Geologist,' vol. v.

Dawson's paper was essentially stratigraphical, but in it he records *Gr. clintonensis* from the Lower Arisaig series of Nova Scotia, and gives a brief preliminary description and figure of a new species of *Dictyonema*, *D. Websteri*, from the *Dictyonema* shales near New Canaan.

1860.

Eichwald,

'Lethæa Rossica,' edit. 2.

A second edition of Eichwald's 'Lethæa Rossica' was published in 1860. In this edition five Graptolite species were described and figured, three being new. The new forms are (1) *Diplog. pennula* (? *Petalograptus*); (2) *D. paradoxus*, and (3) *D. tumidus*. The old species are the (4) *D. distichus*

of Eichwald, and (5) *Monoprion serratus* of Schlotheim. The figures of the new species are very poor, and it is impossible to identify any of them with certainty at the present day. Eichwald re-describes his own *Gorgonia* (*Dictyonema*) *flabelliforme* under the new generic name of **Rhabdinopora**.

1860.

Michel,

"Coupe du terrain
Silurien aux environs
de Domfront." 'Bull.
Soc. Géol. de France,'
ser. 2, vol. xvii.

In this year Michel recorded the existence of Silurian shales, near Domfront, containing *Gr. colonus*, characteristic of stage E. (A collection of Graptolites from this locality was subsequently sent to Barrande, and he identified in addition *Gr. bohemicus*.)

1861.

Salter,

"New Fossils from the
Skiddaw Slates,"
'Geologist,' vol. iv.

In 1861 Salter figured from the Skiddaw Slates a new Graptolite forming the type of a new genus. This is a *Clonograptus*, showing, however, only ten stipes. Salter observes that it certainly does not belong to the genus *Graptolithus*, which includes forms which are simple and perfect from end to end, and concludes, "I shall shortly, I hope, describe the new branched dichotomous form under the name of **Dichograpsus**."

1861.

Billings,

"On the Occurrence of
Graptolites in the Base
of the Lower Silurian,"
'Canad. Naturalist and
Geologist,' vol. vi.

In 1861 Billings reviewed the work of Schmidt ('Silurische formation von Estland,' 1858), and compared the geological appearance of Graptolites in Europe and America, with the intention of showing that the "occurrence of Graptolites in rocks so ancient as those of the Quebec group is not inconsistent with what we know of their geological range in other countries," and that therefore they need not be of the age of the Hudson River group. He concludes, however, that his investigations tend to prove that "Graptolites cannot always be relied upon to show that exposures of rock widely separated from each other are either of a different or of the same age."

1861.

Dalimier,

"Stratigraphie des
terrains primaires
dans la presqu'île du
Cotentin." 'Bull. Soc.
Géol. de France,' ser. 2,
vol. xviii.

In the same year Dalimier recorded the occurrence of Graptolites of the second Silurian fauna from the shales and associated grits above the Fucoid grit in the Peninsula of Cotentin.

1861-2.

McCoy,

"Note on the Ancient
and Recent Natural
History of Victoria,"
'Ann. Mag. Nat. Hist.,'
vol. ix.

In 1861 McCoy had noted the occurrence of several species of Graptolites from the Palæozoic rocks of Victoria in a pamphlet published for the Intercolonial Exhibition. The year following, 1862, the main results of his study of these forms were published in England. He records the following species:—*Diplograpsus pristis*, *D. mucronatus*, *D. rectangularis*, *D. ramosus*, *D. folium*, and *D. bicornis*; *Phyllograptus typus*;

Didymograpsus serratulus, *D. caduceus*, *D. furcatus*; *Graptolites gracilis*, *Gr. Logani*, *Gr. quadrirachiatius*, *Gr. octobrachiatus*, *Gr. ludensis*, *Gr. tenuis*, *Gr. latus*, and *Gr. sagittarius*.

The remarkable similarity between the graptolitic fauna of Australia, America, and that of the Northern Hemisphere appears to have greatly astonished him; and he lays especial stress on the "extraordinary fact of the specific identity of this marine fauna over the whole world during the most ancient Palæozoic periods."

1861. Baily, "Graptolites of Meath, etc.," 'Geol. Soc. of Dublin.'	A paper on the Graptolites of Ireland was published in 1861 by Baily. It is mainly stratigraphical in its bearing, but the various Graptolite species mentioned are briefly described and figured.
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Didymog. Murchisoni is recorded from Bellewstown, co. Meath; and he erroneously asserted that with this form were associated *Gr. Sedgwickii* and *Gr. Nilssonii*. The species (1) *Diplog. pristis*, (2) var. *scalariformis*, (3) *D. mucronatus*, (4) *Gr. gracilis*, and (5) *Cladog. Forchammeri* are recorded and figured by him from "beds of Llandeilo age" in county Clare. As regards the first two of these species, he points out that the specific names given by him are merely provisional. His *D. pristis* var. *scalariformis* appears to be a *Climacograptus*. The example shown on fig. 2*b*, is probably *Climacog. tubuliferus*, Lapw. His *Diplog. mucronatus* is the *D. bimucronatus*, Nich. The structure of the cells in his *Cladog. Forchammeri* are well represented.

From co. Tipperary he records *Gr. priodon* and a new species, *Gr. hamatus* (*Cyrtograptus*).

Referring to the range of the Graptolites in general, Baily concludes that "all the Lower forms are confined to the Lower Silurian division, being most abundant in the lowest series of beds, the equivalents of the Llandeilo Flags; one species only, the *Gr. priodon*, a single form, ranging through the series."

1863. Salter, "Note on Skiddaw Slate Fossils," 'Quart. Journ. Geol. Soc.,' vol. xix.	In 1863 Salter, in an appendix to Harkness' paper on "The Skiddaw Slate Series," recorded and figured several species of Graptolites. They include the (1) <i>Phyllog. angustifolius</i> of Hall, and two species of <i>Tetragraptus</i> . One of these is clearly (2) <i>T. serva</i> , and the other a presumed new species named by Salter (3) <i>Gr. crucialis</i> . This last, however, is identical with the <i>T. quadribachiatus</i> of Hall.
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Two new species of *Dichograptus* are named, (4) *D. aranea* (*D. octobrachiatus*) and (5) *D. Sedgwickii*, and a form is figured with a disc. A figured fragment (fig. 12) assigned by Salter to *Dichograptus* is really an example of *Bryograptus Kjerulfi*. Four species of *Didymograptus* are figured:—(6) *D. caduceus*, (7) *D. geminus*, (8) *D. v. fractus*, and (9) *D. hirundo*. The last two are new forms.

Salter agrees with Huxley's suggestion that the disc in *Dichograptus* is analogous to the basal plate of *Defrancia*, and he regards it as of great systematic importance. He accepts Hall's genera *Dendrograptus* and *Dictyonema*, and points out the strong

external resemblance of *Dictyonema* to *Fenestella*. He adds, "The presence of the projecting Graptolite cells, and horny texture, however, prevents its being confounded with that genus; but the resemblance is very close, and I think we have here a real affinity."

He discusses the geological age of the Skiddaw slates as evidenced by their included Graptolite species, and compares them with the beds of the Quebec group.

1863-4.
Logan,
 "Geology of Canada,"
 and "Graptolites of
 the Quebec Group,"
 'Reports of Progress.'

In the two reports of Logan on the "Geology of Canada," which appeared in 1863-4, Graptolites are referred to, but nothing is added in them to our previous knowledge of the group in general.

They are stratigraphical in their bearings, and Logan distinctly recognises the probable identity in age of the Norman's Kill shales and the Utica and Hudson River groups on the ground of the similarity of their Graptolites.

1863.
Dewalque,
 "Notes sur les Fossils
 Siluriens de Grand
 Manil," 'Bull. de la
 Soc. Géol. de France,'
 ser. 2, vol. xx.

Dewalque recorded in 1863 the occurrence of certain "scalariform impressions" of Graptolites (identified by Barrande) in the Silurian shales of Grand Manil, Belgium, but no names were given.

1863.
Billings,
 "Parallelism of the
 Quebec Group, etc.,"
 'Geol. Survey of
 Canada.'

In the same year Billings again discussed the question of the age of the Quebec group, as evidenced by its included Graptolites. He concludes that it must lie between the middle of the Calciferous group, and the bottom of the Black River limestone. As regards the identity in age of the Chazy and the Quebec groups, he considers (from the dissimilarity in the species) that in a "portion of the Quebec group we have a set of strata representing those which are absent (elsewhere) in Canada." "The remainder may possibly be of the age of the Chazy."

1864-5.
Törnquist,
 "Om Fågelsangs-
 traktens Undersiluriska
 Lager," 'Lunds Univ.
 Årsskrift,' tom. ii.

In 1864-5 Törnquist described and figured six species from the Swedish Lower Silurian beds of Fågelsång. These are (1) *Diplograpsus teretiusculus* (probably including also *Olinacog. Scharenbergi*), (2) *Phyllograptus typus*, (3) *Didymograpsus Murchisoni*, (4) *Dendrograpsus gracilis* (considered by Holm to be a *Pterograptus*), and a new species (5) *Didymograpsus virgulatus*. Finally he gives examples of (6) *Dictyonema flabelliforme*, showing the structure of the branches.

1865.

Kjerulf,

"Veiviser ved geologiske
excursioner i
Christiania omegn,"
'Universitets-program
for andet Halvaar.
Christiania.'

In the catalogue of fossils from the Christiania district, prepared by Kjerulf in 1865, figures are given of species of Graptolites in Etage 2. These are (1) *Dictyonema norvegicum*, Eich., and (2) *Dictyonema graptolithinum* (*D. flabelliforme*). He also records *Gr. gracilis*, Hall (*Pterograptus*, cf. Hohn). Under the name (3) *Gr. tenuis*, Portlock,

Kjerulf figures the branching forms subsequently named and described by Lapworth as *Bryograptus Kjerulfi*. A few species are also recorded from Etage 3. From Etage 8, under the name of (4) *Gr. ludensis*, he figures *M. priodon*, a second species of *Monograptus*, and a form which is probably a *Cyrtograptus*.

1865.

Malaise,

"Notes sur quelques
fossiles du massif
Silurien du Brabant,"
'Bull. de l'Acad. R. de
Bruxelles,' tom. xx.

In 1865 Malaise recorded the discovery of Graptolites in the Silurian shales of Brabant, but did not adduce the names of any of the specific forms obtained by himself.

1865.

Peck,

"Graptolithen schiefer
bei Lauban," 'Neues
Jahrb.'

In the same year four species of Graptolites, identified by Geinitz as *M. sagittarius*, *M. priodon*, *M. colonus*, and *M. Sedgwickii*, were found by Peck in the Graptolite shales near Lauban.

1865.

Hall,

"Graptolites of the
Quebec Group," 'Geol.
Surv. of Canada,' Dec. 2.

In 1865 the valuable results of Hall's long-continued researches on the Graptolites of America, worked out by him during the previous ten years, and already partly laid before the public in various papers, were embodied in a collective and exhaustive monograph entitled 'The Graptolites of the Quebec Group.' It will be well to give here a general summary of the whole, so as to realise fully the views of this great palæontologist on the Graptolites.

The work is in the main descriptive, almost every species being illustrated by several drawings of great excellence. Hall acknowledges only one inclusive family—*Graptolitidæ*, and gives the following table of the component genera :

Classification.

Family GRAPTOLITIDÆ.

I.

Species consisting of stipes or fronds, with a bilateral arrangement of the parts; a solid axis with a common canal extending along each series of cellules.

1. The successive buds developed in tubular cellules which are usually in contact for a greater or less proportion of their length, and inclined towards the axis.

(a) Cellules in single series along one side of a common solid axis. Stipes, two or more, from a common origin, with or without a central disc. Sub-genera *Monoprion*, *Didymograptus*, *Monograptus*, *Tetragraptus*, etc.

(b) Cellules on one side of slender branches, which are developed on one or two sides of a long slender axis or rachis, the free extremities of which are likewise celluliferous. Ex. *Gr. gracilis* and *Gr. divergens*.

(c) Cellules developed in parallel arrangement on two sides of a common solid axis. Stipes narrow, elongate. Sub-genus *Diprion*, = *Diplograptus*.

(d) Cellules developed in a cruciform arrangement on the four sides of a common or coalescent axis. Stipes elliptical or sub-elliptical.

2. Cell-apertures excavated in the margins of the stipes, without tubular or cup-form extension; the cell-apertures upon one or both sides of the stipe. *Graptolithus bicornis* and others.

3. Solid axis eccentric or subexterior, with cellules developed in parallel ranges on opposite sides of the stipe, and in contact throughout their entire length.

Retiolites. (a) Known only as separate stipes, with reticulate test.

Retiograptus. (b) Occurring as single stipes, and as compound fronds; test smooth.

II.

Species having a common trunk, or growing in sessile groups of stipes from a common origin, without distinct bilateral arrangement of the parts. Cellules in single series on one side of the stipes or branches, and arranged along a common canal or axis.

1. Branches free (*i. e.* not connected by transverse bars); cellules in contact
Dendrograptus. or closely arranged.

2. Stipes and branches more or less regularly united in a reticulate front,
Dictyonema. without elongate stem.

3. Branches unfrequently and irregularly connected by transverse processes.
Callograptus.

4. Stipes round or flattened, growing in groups, and bifurcating above;
Inocaulis. margins denticulate; surface rough and scaly.

III.

Slender cylindrical branches, with tubular cellules arranged in single (or in double) series. Cellules not in contact in any part of their length.
Rastrites.

IV.

Species having a common axis or rachis, with slender lateral alternating branchlets. Cellules unknown.
Thamnoograptus.

V.

Species having a common axis, more or less frequently bifurcating, with pinnulæ closely and alternately arranged on the opposite sides; cell-apertures on one face of the pinnulæ.
Ptilograptus.

VI.

A simple flexuous rachis, with slender flattened pinnulæ, arranged in alternating order at close and regular intervals on the two sides. Cell-apertures unknown or circular.
Buthograptus.

VII.

Strong stems, which are numerous branched. Branches and branchlets slender, arranged in whorls. Cellules undetermined.
Oldhamia.

Nomenclature.—It will be seen from the above synopsis that Hall still maintains his original view that all the simple stiped forms described by Barrande and others are really only isolated branches of a more complex form, and he therefore rejects all such generic names as *Monograptus*, *Didymo-*, *Tetra-*, and *Dichograptus*. He writes, "These subdivisions may be of some value when the entire frond and all its appendages are preserved, but unfortunately this is rarely so; and when we have but fragments of the stipes or branches there is no force or value in the application of these terms; we are thus reduced to the necessity of adopting the old term *Graptolithus*." In criticising McCoy's genus *Didymograptus* he points out that the name had been used for two distinct groups, namely, those of the type of *Graptolithus patulus*, or the true *Didymograpti* (as we know them at the present day), and those of the type of *Gr. divaricatus* (*Dicellograpti*), and he shows how valueless are the genera founded on the number of stipes by citing the case of *Didymog. caduceus* (Salter), which he believes to be a four-stiped form, though it so closely simulates one with two stipes.

Hall points out that the corneous disc in Graptolites is not a character of generic value, as it occurs in some 4-, 8-, and 16-stiped forms, while other species

with the same number of stipes do not possess one. He does not accept Geinitz's genus *Cladograpsus*, and agrees with Bronn in rejecting Geinitz's *Nereograpsus* and Emmon's *Nemapodia*, which are probably worm tracks. Emmon's genera *Glossograpsus* and *Nemagrapsus* are rejected by Hall, but he observes that Emmon's *Staurograpsus*, "if accurately represented in the figure, merits generic distinction."

He retains the genus *Diplograpsus* of McCoy, not on account of its form, but on account of the shape and arrangement of the cellules, which are the same as those in the various species of *Graptolithus* (*Didymograptus*) described by himself. From this genus *Diplograpsus*, however, as previously accepted, Hall separates under the name *Climacograptus* those double forms, the cell-apertures of which are "excavated in the margins of the stipes, without tubular or cup-form extension." He gives a very careful and detailed description of the structure of this new genus, illustrated by excellent figures. He regards his *C. bicornis* as the type, but includes also *Pr. teretiusculus*, His., and *D. rectangularis*, McCoy, in the same genus; and he conceives that many if not all of the scalariform specimens figured by previous authors belong to species of this character.

Hall also recognises the fact that the cells in such forms as *Gr. ramosus* and *Gr. Forchammeri* are similar in structure to those of *Climacograptus*, and he proposes the sub-generic title of *Dicranograptus* to include all such species.

Barrande's genera *Rastrites* and *Retiolites* are retained, but Hall differs from Barrande in believing that in the latter genus the axes are two in number—on one side a straight cylindrical solid axis, and on the opposite side an undulating or zigzag filiform axis. The structure of *Retiolites*, so far as Hall was able to work it out from the material at his disposal, is given in illustrative figures.

As regards his own genus *Retiograptus*, Hall supposes that "the two sides of the stipes are very unlike each other in form and external characters, as is the case in *Retiolites*."

The four genera of Dendroid forms, viz. *Dendrograptus*, *Callograptus*, *Dictyonema*, and *Ptilograptus*, are placed by him in the family of the Graptolitidæ, but he suggests that when further information has been obtained as to their structure, it may be necessary to separate them from this family. In *Dictyonema* he is unable to recognise a solid axis, but he believes that it existed in *Ptilograptus*. The peculiar genera *Inocaulis*, *Buthograptus*, and *Oldhamia* he holds can only be doubtfully classed among the Graptolitidæ.

It may be noted that Hall here first adopts the termination "graptus" instead of "grapsus" for all his new genera, "since the latter is used in description of Crustacea." This modification of the earlier terminology may be said to be universally adopted at the present day.

Description of Species.—The following large number of species are described and figured by Hall in this work (the generic names in brackets are those employed at the present day):—

- (*Didymograptus*) . (1) *Gr. nitidus*, (2) *Gr. patulus*, (3) *Gr. bifidus*,
 (4) *Gr. indentus*, (5) *Gr. extenuatus*, (6) *Gr. constrictus*,
 (7) *Gr. similis*, (8) *Gr. arcuatus*, (9) *Gr. extensus*,
 (10) *Gr. pennatulus*.
- (*Tetragraptus*) . (11) *Gr. byronoides*, (12) *Gr. denticulatus*,
 (13) *Gr. quadribrachiatus*, (14) *Gr. fruticosus*,
 (15) *Gr. crucifer*, (16) *Gr. Headi*, (17) *Gr. alatus*,
 (18) *Gr. Bigsbyi*.
- (*Dichograptus*) . (19) *Gr. octobrachiatus*, (20) *Gr. octonarius*.
- (*Loganograptus*) . (21) *Gr. Logani* and a variety.
- (*Clonograptus*) . (22) *Gr. flexilis*, (23) *Gr. rigidus*, (24) *Gr. abnormis*,
 (25) *Gr. Richardsoni*, (26) *Gr. ramulus*.
- Diplograptus* . (27) *Gr. pristiniiformis*, (28) *Gr. inutilis*, (29) *Gr. putillus*,
 (30) *Gr. quadrimucronatus*.
- Climacograptus** . (31) *C. antennarius*, (32) *C. bicornis*, (33) *C. typicalis*.
- Dicranograptus** . (34) *D. ramosus*.
- (*Leptograptus*) . (35) *Gr. flaccidus*.
- Retiolites* . (36) *R. ensiformis*, (37) *R. venosus*.
- Retiograptus* . (38) *R. tentaculatus*, (39) *R. eucharis*.
- Phyllograptus* . (40) *P. typus*, (41) *P. ilicifolius*, (42) *P. anna*,
 (43) *P. angustifolius*.
- Dendrograptus** . (44) *D. flexuosus*, (45) *D. divergens*, (46) *D. striatus*,
 (47) *D. erectus*, (48) *D. diffusus*, (49) *D. gracilis*.
- Callograptus** . (50) *C. elegans*, (51) *C. Salteri*.
- Dictyonema* . (52) *D. irregularis*, (53) *D. robusta*, (54) *D. Murrayi*,
 (55) *D. quadrangularis*.
- Ptilograptus** . (56) *P. plumosus*, (57) *P. Geinitzianus*.
- Thamnoagraptus* . (58) *T. anna*.
- (*Monograptus*) . (59) *Gr. Clintonensis*.

In his introductory chapters Hall devotes various sections of his work to the consideration of such matters as the structure, method of reproduction, and mode of existence of the Graptolites. Such of his views as were new to the science of the time may here be briefly summarised.

Structure.

The Radicle.—This was the name employed by Hall for the basal spine, initial spine, or “initial point” of the Graptolite. He admits that in those species with a single row of cellules it may have served as a temporary organ of attachment in the earlier period of its growth, “though all the evidence is opposed to this view.” In *Retiograptus*, however, it “is only a broken process of attachment of the individual

stipe, which existed as one of the members of the entire frond, the true initial point of which would be in the centre of the whole." It is clear from Hall's observations that the term was not in all cases given by him to one and the same structure, sometimes being identical with what is now known as the sicula (*Cænograptus*), sometimes to the apical part of the sicula (*Didymograptus*), and sometimes to the "apertural spine" of the sicula (*Diplograptus*). Hall emphasises, however, one important fact, now known to be true of the sicula, viz. that the radicle passes into the "commencement of the solid axis."

Funicle.—Hall believes that in the Graptolites with four stipes (*Tetragraptus*) "the condition appears like that of two individuals of the two-stiped forms conjoined by a straight connecting process of greater or less extent, destitute of cellules," and this he calls the "funicle." The greater the number of stipes, the greater are the number of the divisions of this non-celluliferous funicle. (It has subsequently been shown by more recent observers that the non-celluliferous character of the dividing and subdividing primary and secondary stipes is only apparent, being merely due to their mode of preservation. Consequently Hall's funicle as originally defined by him is non-existent.)

Central Disc.—This curious structure, first recognised and described by Hall, "appears to be composed of two laminae which, at least in the central parts, are not conjoined, and the space is probably occupied by some softer portion of the animal body." According to Hall, the functions of this disc are to "give strength and support to the bases of the stipes," but beyond this "it probably serves other purposes of the animal economy," and he seems to hint that reproduction was one of these (*loc. cit.*, p. 35).

Solid Axis.—Hall adds but little in this work to our knowledge of the "solid axis," merely corroborating Barrande's observations; but he recognises its importance in the Graptolite structure as a whole, regarding it as the "foundation on which the other parts are erected." Although believing the axis to be solid, he distinctly acknowledges in a note that "the aspect of the axis, when marked by a longitudinal groove, is precisely that which a *hollow* cylindrical body would have if extremely compressed" (p. 22).

Common Canal.—While recognising the fact that the common canal gives rise to the cellules in most cases, Hall points out that in such forms as *Gr. gracilis* it must also give origin to "simple small stipes with solid axis, common canal, and cellules." He lays great stress on this double function of the common canal, but unfortunately his view of this question is largely due to his erroneous idea of the non-celluliferous character of the main stipe in *Gr. gracilis*. In the case of *Diplograptus*, Hall considers that there may be either two common canals separated by the "axis becoming a flattened plate," or else a single canal with only a filiform axis. He did not therefore distinguish between the septal walls between which the axis runs, and the axis itself. In *Phyllograptus* he infers that

The lower border rounded, its curvature being continued up to the base of the posterior ear. Hinge-line short and straight. Umbones triangular, pointed, central, incurved. Anterior ear much compressed, sharply defined from the valve by a curved groove, the right ear slit for the byssus. Posterior ears small, triangular, depressed, and flattened, also separated from the valve by a deep groove.

Interior.—Unknown.

Exterior.—The left valve is ornamented with from twelve to twenty thick, radiating, nodular, distant ribs, which project as spines below the lower margin of the shell in front; between each pair of ribs is a thin, irregular, moniliform, linear rib. The spaces between the ribs are smooth, but the whole surface of the valve is irregularly nodular. The anterior ear has four or five radiating ridges, the posterior also several. The latter has several spines projecting obliquely backwards and upwards along its upper border. The right valve has numerous close, rounded, radiating ribs, on which are nodular swellings, caused by concentric undulations crossing the ribs. The right anterior ear has about six distant, nodulose, radiating ribs, the intervals between them showing close concentric lines.

Dimensions.—Pl. XIV, fig. 3, the type, measures—

Antero-posteriorly	.	.	.	35 mm.
Dorso-ventrally	.	.	.	40 mm.

Localities.—England: the Carboniferous Limestone of Castleton, Derbyshire; Poolvash, Isle of Man. Ireland: the Carboniferous Limestone of Little Island and Black Rock, co. Cork; Tankardstown and Ardsbally, co. Limerick.

Observations.—The type of M'Coy's *Pecten Murchisoni* is preserved in the Science and Art Museum, Dublin. It is a fine specimen of a left valve (Pl. XIV, fig. 3). The marking on the left valve is identical with that of *Pterinopecten Dumontianus*, de Kon., sp., but the latter shell is at once distinguished by its long hinge-line, the long, gradually compressed posterior ear, and the numerous ribs on both ears. The nodulose character of the ribs is not very marked in the type. I have noticed much variation in a suite of specimens from Castleton and Poolvash.

An examination of the type of *Pecten ovatus*, M'Coy, preserved in the Museum of Science and Art, Dublin, in the Griffith Collection, has led me to the conclusion that the shell is the young of *A. Murchisoni*. The contour is the same, and so is the general character of the ornament. M'Coy figures the secondary thin rib between a pair of large ones in an enlarged view. The shell is so small that only one secondary rib is figured.

AVICULOPECTEN INEQUALIS, sp. nov. Plate XIV, figs. 14, 15.

Specific Characters.—Shell of medium size, inequivalve, the right being much smaller than the left valve, and somewhat flatter, slightly oblique. Antero-posterior

diameter much less than the dorso-ventral diameter, ovato-rectangular. The anterior margin of the valve slightly convex, the lower margin much more so, the posterior margin almost straight. The hinge-line straight. Ears large and depressed, pointed, with each margin falcate; the right anterior ear deeply grooved for the byssus. The posterior ears very deep and long, the fold separating them from the valve reaching the margin low down. Umbones small and pointed, placed in front of the centre of the hinge-line.

Interior.—Unknown.

Exterior.—The surface is ornamented with several distant, obscure, broad, radiating ribs, separated by shallow grooves. The whole surface seems to be smooth. Occasionally there are concentric lines and rugæ of growth. The ears have much the same characters as the rest of the valve.

Dimensions.—Pl. XIV, fig. 14, a left valve, measures -

Antero-posteriorly	.	.	.	37 mm.
Dorso-ventrally	.	.	.	53 mm.

Locality.—Scotland: the Carboniferous Limestone series of Chance Pit 21, Kinneil, near Boness (roof of Smithy Coal).

Observations.—This very characteristic species is founded on a right and left valve on one surface of a slab of shale, and a smaller left valve on the other surface. It would seem that this specimen is referred to in the memoir of the Geological Survey of Scotland, explanation of sheet 31, p. 70, as *Aviculopecten* (near *A. planocostatus*, McCoy, sp.). It is accompanied by a marine fauna, but many of the species mentioned in the list are not named with certainty. Of course this shell has no affinity with *A. planocostatus*, McCoy, sp., which has quite distinct characters; but the original drawing is so hypothetical that it is not to be wondered that other shells have been confused with it. This species is now referred to the genus *Amusium* (see p. 123).

The left valve of *A. inequalis* seems to have been much larger than the right valve, and to have overlapped this on all sides except that of the hinge-line. I have not noticed this character in any other Carboniferous Pectiniform shell; otherwise the shape of the left valve is very similar to that of *A. Murchisoni*.

AVICULOPECTEN DEORNATUS, *Phillips*, sp., 1836. Plate XVIII, figs. 10—14.

PECTEN DEORNATUS, *Phillips*, 1836. Geol. Yorks., pt. ii, p. 213, pl. vi, fig. 26.

— — — — *McCoy*, 1844. Synops. Carb. Foss. Ireland, p. 91.

AMUSIUM ? DEORNATUM, *McCoy*, 1855. Brit. Pal. Foss., p. 478.

Specific Characters.—Shell small, broadly ovate, moderately convex, equivalve, almost equilateral. The lower margin almost semi-circularly curved. The hinge-

makes the accurate determination of its length a matter of some difficulty, since the apex merges gradually into the nema. The nema is, however, rarely preserved for any length, no examples being known in which it exceeds 5 or 6 mm.

The general lines of development of the polypary are the same as those already described in the case of *Didymograptus*, but the presence of what may be termed *two crossing canals* instead of *one* indicates in this genus a special phase of development. The presence of these canals connecting the primary and secondary stipes is usually indicated in the reverse aspect by a thickening in the dorsal region of the proximal end. It is obvious in the more robust forms,

FIG. 61.—*Leptograptus* cf. *flaccidus* (Hall).



Reverse view, showing the thickening produced by the two crossing canals. Hartfell Spa, Hartfell Shales. Coll. Lapworth.

and in the rare specimens preserved in relief, but is naturally difficult of detection in the very slender and compressed specimens. Nevertheless we believe that these two crossing canals are present in every case and are to be regarded as one of the characteristic features of the genus *Leptograptus*.

The thecal apertures are inclined with respect to the general ventral margin of the polypary and are slightly introverted. In front of the aperture, the ventral wall of the succeeding theca has the aspect of having been pressed inwards, thus giving origin to a kind of "excavation" in the general ventral margin of the polypary itself, and the aperture opens partly within this excavation. The ventral margin of each individual theca has a slightly sigmoid curvature, and this character with the "excavation" and inclined aperture is very characteristic not only of the *Leptograpti*, but of the family as a whole.

It is not possible in the present state of our knowledge to divide the *Leptograpti* into any definite serial groups, so intimately are they related to one another in their habit of growth. Extreme forms are no doubt readily distinguishable, but they are connected by a series of forms which grade so insensibly into each other that it is impossible to draw a divisional line between them. Thus a flexed form like *L. flaccidus*, by gradual increase in the amount of flexure, passes on the one hand into a form with a sigmoid habit such as *L. capillaris*; and on the other hand, by decrease in the amount of curvature of the stipes, into a more or less straight form like *L. latus* or *L. grandis*, and yet the sigmoid, the flexed, and the relatively straight forms are obviously distinct.

The following species are at present included in the genus *Leptograptus*:—*L. flaccidus*; *L. flaccidus*, var. *spinifer*; *L. flaccidus*, var. *macilentus*; *L. flaccidus*, var. *macer*; *L. flaccidus*, var. *arcuatus*; *L. capillaris*; *L. validus*; *L. validus*, var. *incisus*; *L. grandis*; *L. latus*; *L. ascendens*.

Leptograptus flaccidus (Hall). Plate XIV, figs. 1 *a—g*.

1865. *Graptolithus flaccidus*, Hall, Grapt. of Quebec Group, Suppl., p. 143, pl. ii, figs. 17—19.

1867. Non *Didymograpsus flaccidus*, Nicholson, Geol. Mag., vol. iv, p. 111, pl. vii, figs. 1—3.

1870. Non *Didymograpsus flaccidus*, Nicholson, Ann. Mag. Nat. Hist. [4], vol. v, p. 353, pl. vii, fig. 6.

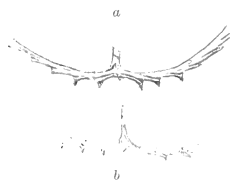
1876. *Leptograptus flaccidus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 73.

Stipes narrow, flexed, several cm. in length, widening gradually and persistently from their origin to a maximum width of about 1 mm. Sicula 1·5—1·6 mm. in length. Thecae uniformly narrow, ten to eight in 10 mm., inclined at 15°, seven to eight times as long as wide, free two thirds to one half their length. Apertural margins narrow, straight, or slightly concave when compressed, submucronate, very slightly introverted.

Description.—The stipes characteristically show graceful double curvature in their more proximal parts; close to the sicula they are convexly curved with respect to their ventral margins, and then bend outward and upward with a concave sweep, running ultimately in an approximately horizontal direction; this curvature is, however, by no means constant in amount. The stipes widen gradually throughout the first five or six centimetres of their length, from a width of ·5 mm. opposite the aperture of the first theca to a maximum width of about 1 mm., which is thereafter maintained. The stipes must frequently have been exceedingly long, since fragments having a length of 8—10 cm. are of frequent occurrence, and that these belong to the distal parts of the stipes only is evidenced by their uniform breadth.

The sicula measures 1·5 to 1·6 mm. in length. The first theca (th. 1¹) appears to originate at a point about ·5 mm. above the base; it grows at first vertically downward, but then bends sharply round almost at right angles, so that its apertural part is perpendicular to the long axis of the sicula, and the aperture itself is approximately parallel to it. In the reverse aspect of the polypary only a small part of the apertural region of the sicula is visible below the outer walls of th. 1¹ and th. 1²; the crossing canal (c.c.¹) is seen to be but very slightly oblique, and the aperture of th. 1² lies on the same level as that of th. 1¹, giving a very symmetrical appearance to the proximal end as a whole. Another characteristic feature of this reverse aspect of the polypary is the mode of growth of th. 1², which almost entirely conceals the initial part of th. 1¹. The appearance of the polypary also clearly indicates the presence

FIGS. 62 *a* and *b*.—*Leptograptus flaccidus* (Hall).

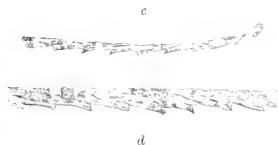


a. Reverse view. Enlargement of part of Pl. XIV, fig. 1 *b*.
b. Proximal extremity, showing complete sicula. Enlargement of part of Pl. XIV, fig. 1 *c*.

of a second crossing canal (c.c.²) somewhat similar in character to that observed in the case of *Didymograptus gibberulus*; th. 2¹ appears to be developed from the initial part of th. 1², and th. 2² also from th. 1². This is a matter of special interest, because this type of development is known also in the Dicanograptidæ and the Diplograptidæ.

The two earliest thecæ are only about half as long as those subsequently developed, and their apertures are conspicuously mucronate, but not spinose, a feature which is shared by th. 2¹, th. 3¹, th. 2², and th. 3² only.

FIGS. 62 c and d.—*Leptograptus flaccidus* (Hall).

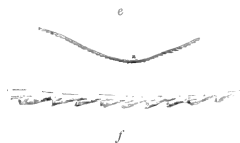


- c. Proximal thecæ. On same slab as Pl. XIV, figs. 1 c, d.
d. Distal thecæ. Enlargement of part of specimen on same slab as Pl. XIV, fig. 1 b.

about one-half their length, but may be rather less.

Remarks.—The British specimens of *L. flaccidus* agree very closely with the

FIGS. 62 e and f.—*Leptograptus flaccidus* (Hall).



- e. Specimen from Hall's original locality, nat. size, for comparison with British examples. Utica Slates, Lake St. John. Coll. Canadian Geological Survey.
f. Enlargement of theca of Fig. 62 c.

its general form and the character of the proximal end.

Horizon and Localities.—Lower Hartfell Shales.

S. Scotland: Mount Benger Burn; Hartfell Spa; Syart Law Seaur; Craigmichan Seaur; Berrybush Burn; Stinchar Valley; Earl Hill; Seab Cleuch; Yellow Mire; Penwhapple Burn. *N. Ireland:* Ballygrot; Tramore Bridge. *N. Wales:* Derwendeg, near Conway.

Associates, etc.—*L. flaccidus* occurs in profusion in many Scotch localities where the lower zones of the Hartfell Shales are well exposed. It is a common fossil in

The average length of a theca in the maturer parts of a stipe is about 2 mm.; the width of each theca is uniform throughout its length, and averages .2—3 mm.; each thecal aperture occupies half the width of the stipe in the proximal region, but distally the proportional fraction is much less (one third). The thecæ average nine to eight in 10 mm. distally, but they are rather more closely set near the sicula, being commonly about eleven in 10 mm.; their inclination is uniformly low, and the overlap is usually

a higher number of thecæ in a given unit of length, but possibly he adopted a different method of measurement, for the American specimens in the collection of the Canadian Geological Survey, which we have examined, agree precisely with the British specimens in this respect.

Affinities.—*L. flaccidus* is characterised by its curvature, by the gradual and persistent widening of the stipes for the first few centimetres of their extent, and by the number of thecæ in a given unit of length. It is distinguished from its varieties by

the zone of *Pleurog. linearis*, and is often found in the zone of *Dicranog. Clingani*. It is commonly associated with *Leptog. capillaris*, *Diplog. truncatus*, var., and other *Diplograpti* of the "*foliaceus*" type.

Good specimens are in the collections of Lapworth, the Geological Survey of Scotland, and the Woodwardian (Sedgwick) Museum.

Note.—*L. flaccidus* has a fairly large number of varieties distinguished by their general habit, number of thecae in a given unit of length, and the character of the proximal end. Most of these varieties, as well as *L. flaccidus* itself, in addition to a two-stiped form, present us with occasional mutations in which an extra stipe or branch is present. This stipe originates from the sicula or its immediate neighbourhood, and may be either simple or compound.

FIG. 62 g.—*Leptograptus flaccidus* (Hall).



Centribrachiate form. Enlargement of part of Pl. XIV, fig. 1 g.

In these centribrachiate mutations we have been unable to determine with certainty how this third stipe arises. Sometimes it looks as if it were merely the prolongation of the apical part of the sicula, but in other specimens the apex of the sicula is clearly visible. It seems possible that it is an abnormal growth from the initial bud from which the two normal stipes of the polypary are developed, or in other words, it is an extra division of the crossing canal. Thus the branching, instead of being deferred to a late stage in the growth of the polypary, as in the *Pleurograpti*, is concentrated in its early stages.

Var. *spinifer*, var. nov. Plate XIV, figs. 2 a—c.

Description.—In addition to *L. flaccidus*, there is found on approximately the same horizon, a somewhat closely allied form, which differs from the typical species in the mode of origin of its stipes, its more irregular curvature, its longer sicula, and the more conspicuous spines on the proximal thecae. As regards the size of the stipes and their increase in width, this variety agrees closely with the typical species.

The curvature of the stipes is very variable: at first and for some little distance, it is occasionally markedly convex with respect to the ventral margins, far more so than in *L. flaccidus*; it may then become slightly concave, and ultimately the stipes appear to run in an approximately horizontal direction; in some specimens, however, the stipes are scarcely curved at all. They widen gradually and persistently throughout their length from .4 mm. (exclusive of spines) near the sicula, to .8 mm. near the distal end; in very long forms a breadth of 1 mm. may be attained, but the smaller narrower forms seem to be of commoner occurrence.

The sicula has a length of 2 mm. or rather more; it is broad at the base, but tapers somewhat quickly above the dorsal wall of the polypary. The first theca

FIG. 63 a.—*Leptograptus flaccidus*, var. *spinifer*, nov.



Proximal end, showing apical origin of theca 1¹. Enlargement of Pl. XIV, fig. 2 a.

(th. 1¹) appears to arise near the apex of the sicula, at a point 1.2 mm. above the aperture of the sicula. Th. 1¹ grows at first vertically downward until the level of the sicula aperture is reached; it then bends outward nearly horizontally and from it th. 1² is developed, but in the reverse aspect of the polypary the initial part of th. 1² and much of th. 1¹ are

concealed by the growth of th. 2¹ and th. 2². The crossing canals are approximately horizontal, and the earliest thecae, generally three in number, developed on either side of the sicula, have conspicuous spinal processes growing from their apertures; these are as long again as the width of the stipe, so that while the normal width of the stipe measures .5 mm., when the spines are preserved the total breadth is as much as 1 mm.

The thecae number nine to ten in 10 mm., a number which appears to be constant

FIG. 63 b.—*Leptograptus flaccidus*, var. *spinifer*, nov.



Distal theca. Enlargement of part of specimen on same slab as Pl. XIV, fig. 2 a.

at any point along the length of the stipe; their average inclination is about 15° or a little less, and they are in contact for about half their length. Each theca has a length of about 2 mm., and the aperture is somewhat narrow, occupying commonly about one third of the length of the stipe.

Affinities.—*L. flaccidus*, var. *spinifer*, is allied to another variety of *L. flaccidus*, var. *macilentus*, in the general character and form of its stipes. It differs in the mode of origin of the stipes, in having spines on the proximal thecae, and a slightly greater number of thecae in the same unit of length.

Horizon and Locality.—Hartfell Shales.

S. Scotland: Hartfell Spa.

Associates, etc.—Var. *spinifer* occurs in the Hartfell Shales of S. Scotland, approximately on the same horizon as the typical form, but its exact associates are unknown. The best specimens, including the type, are in Lapworth's collection.

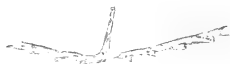
Var. **macilentus**, Lapworth MS. Plate XIV, figs. 3 a—c; and Plate XV, figs. 1 a—c.

Description.—A second variety of *L. flaccidus*, named var. *macilentus*, differs from the typical form chiefly in the greater rigidity of its stipes, their irregular curvature, and in the characters of the proximal end and of the thecae, while the length of the sicula also is somewhat greater.

The stipes are characteristically rigid, but in some specimens their proximal

curvature is considerable, and it is maintained to the distal extremities. The stipes at their origin have a width of .4 mm., widening to 1 mm. within a length of 3 cm.

FIG. 64 a.—*Leptograptus flaccidus*, var. *macilentus*, Lapw. MS.



Obverse view. Enlargement of part of Pl. XIV, fig. 3 b.

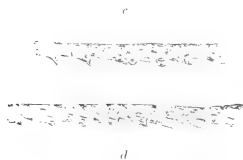
FIG. 64 b.—*Leptograptus flaccidus*, cf. var. *macilentus*, Lapw. MS.



Obverse view. Enlargement of part of specimen on same slab as Pl. XV, figs. 1 b, c.

curved than is usually the case in the *Leptograpti*; their more pronounced sigmoid curvature, accompanied by the greater introversion of the apertures, approaches the *Dicellograptus* type of cell.

FIGS. 64 c and d.—*Leptograptus flaccidus*, var. *macilentus*, Lapw. MS.



c. Distal thecae. Enlargement of part of Pl. XIV, fig. 3 a.

d. Distal thecae. Enlargement of part of Pl. XV, fig. 1 a.

fell Shales, where it occurs in the zone of *Pleurog. linearis*, and up to the present time it has been recorded from S. Scotland alone. It occurs at Dobb's Linn and Hartfell Spa, associated with *Pleurog. linearis*, *Leptog. flaccidus*, and *Diplog. truncatus*, var. Several well-preserved specimens are in Lapworth's collection, and a few are in the collections of the Woodwardian (Sedgwick) Museum and the Authors.

Var. *macer*, var. nov. Plate XV, figs. 2 a—i.

Description.—Another variety of *L. flaccidus* characterised by the tenuity of its stipes has also been recognised, and to it the name var. *macer* has been given. Its stipes are 5—7 cm. or more in length, they are commonly directed upward and

The sicula measures 1.6—2 mm. in length, and th. 1¹ seems to originate about .5 mm. above the aperture. Th. 1¹ and th. 1² have slightly mucronate apertures, but none of the thecae subsequently developed show this character. The thecae number nine to eight in 10 mm.; the free outer walls are curved, are inclined at 15°, and have a length of 2 mm.; they are five times as long as wide, and overlap one half to one third of their extent; the apertural margins are introverted, and occupy one half to one third of the width of the stipe. The free outer walls of the mature thecae are more curved than is usually the case in the *Leptograpti*; their more pronounced sigmoid curvature, accompanied by the greater introversion of the apertures, approaches the *Dicellograptus* type of cell.

Affinities.—*L. flaccidus* var. *macilentus* is allied to var. *spinifer* in general form, but differs from it in the character of the proximal end, in the absence of spines on the proximal thecae, and in having fewer thecae in the same unit of length.

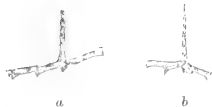
Horizon and Localities.—Lower Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Dobb's Linn; Hartfell Spa.

Associates, etc.—This characteristic variety of *L. flaccidus* has only been found in the Lower Hart-

outward at a wide angle of about 250° , and their slight curvature is variable in direction and amount; they are characteristically narrow, but widen somewhat in a distal direction, having a width at their origin not exceeding $\cdot 3$ mm., and a maximum breadth near the distal end of $\cdot 6$ mm.

FIGS. 65 a and b.—*Leptograptus flaccidus*, var. *macer*, nov.



a. Obverse view.
b. Reverse view. Both on same slab as Pl. XV, fig. 2 b.

The sicula is a long tapering cone about 2 mm. in length, exclusive of the nema, which is occasionally preserved; the origin of the stipes is basal, and the first thecae grow at once obliquely outward, giving a characteristic look to the proximal end; thecae 1^1 and 1^2 are furnished with a small spine.

The thecae are very long and narrow, and are more remote than in any other

FIG. 65 c.—*Leptograptus flaccidus*, var. *macer*, nov.



Distal theca. Enlargement of part of Pl. XV, fig. 2 b.

species of *Leptograptus*. There are six in 10 mm. along the greater part of the length of the stipes, but eight in 10 mm. quite close to the sicula; they have an average length of $2\cdot 5$ mm., and their apertures occupy about one-half the width of the stipe.

Affinities.—Var. *macer* perhaps resembles var. *macilentus* more closely than any other variety of *L. flaccidus*. The resemblance lies in the length of the sicula and the character of the proximal end; it may, however, be readily distinguished from that variety by the remoteness of its thecae and the greater tenuity of its stipes.

Horizon and Localities.—Lower Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Hartfell Spa; Beleraig Burn.

Associates, etc.—Var. *macer* occurs in some abundance in the upper zone of the Lower Hartfell Shales, where it has been found in association with *L. flaccidus*, *L. capillaris*, *Diplog. truncatus*, *Diplog. foliaceus*, var. *vulgatus*, and *Climacog. tubuliferus*.

Good specimens are in the collections of Lapworth and the Authors.

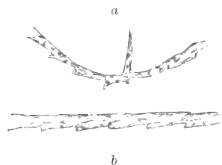
Var. *arcuatus*, var. nov. Plate XV, figs. 3 a—c.

Another variety of *L. flaccidus* shows marked curvature of its stipes, and generally approaches the sigmoid form characteristic of *L. capillaris*. The stipes are several centimetres long, and widen throughout their length from a breadth of $\cdot 4$ mm. to a maximum width of 1 mm., which is attained at their distal extremities.

The sicula is conspicuous, measuring 2 mm. in length.

The thecae number seven to eight in 10 mm., and in their general characters resemble those of the typical species.

FIGS. 66 a and b.—*Leptograptus flaccidus*,
var. *arcuatus*, nov.



a. Obverse view. Enlargement of part
of Pl. XV, fig. 3 a.
b. Distal thecae. Enlargement of part
of Pl. XV, fig. 3 a.

Affinities.—Var. *arcuatus* is somewhat closely allied to *L. capillaris* as respects its habit, but the stipes are less curved, and the thecae show more affinity with those of *L. flaccidus*.

Horizon and Locality.—Lower Hartfell Shales.

S. Scotland: Hartfell Spa.

Associates, etc.—Var. *arcuatus* occurs on slabs in the Lower Hartfell Shales in great profusion, to the exclusion of all other Graptolite forms. Its associates are unknown. The best specimens are in Lapworth's collection.

***Leptograptus capillaris* (Carruthers).** Plate XV, figs. 4 a—d.

1855. Non *Nemagraptus capillaris*, Emmons, American Geology, vol. i, p. 109, pl. i, fig. 7.

1868. *Cladograptus capillaris*, Carruthers, Geol. Mag., vol. v, p. 130, pl. v, fig. 7.

1875. Non *Nemagraptus capillaris*, Hopkinson, Quart. Journ. Geol. Soc., vol. xxxi, pl. xxxiv, figs. 2 a, 2 b.

1876. *Leptograptus capillaris*, Lapworth, Cat. West. Scot. Foss., pl. iii, fig. 72.

Stipes commonly 4—8 cm. in length, slender and very much flexed, widening from a breadth of about .2 mm. near the sicula to a maximum of .5 mm. in the more distal parts of the stipes. Sicula about 1.7 mm. in length, but rarely complete. Thecae eight to ten in 10 mm. on inner or outer side of curve, inclined at a very low angle, and free about one-half of their length. Apertural margins very narrow, inconspicuous.

Description.—The stipes are always more or less slender and thread-like; they never exceed .5 mm. in width. Their curvature is very pronounced and extremely characteristic, each stipe frequently describing the greater part of a circle in the course of its growth in an upward or downward direction; the curved stipes may cross each other, or may be coiled upon each other, or upon themselves, so that there is great variety in the ultimate form attained, the only constant feature being the excessive amount of curvature.

FIG. 67 a.—*Leptograptus capillaris* (Carr).



Obverse view. Hartfell Spa, Hartfell
Shales. Coll. Lapworth.

The sicula is 2 mm. in length and very slender, but is seldom completely preserved.

The characters of the thecae are usually hard to determine; owing to the extensive tenuity of the stipe and its curvature, they are but rarely seen in continuous succession, and their apertures are so minute, except in the case of th. 1¹ and th. 1², that they are generally visible

FIG. 67 b.—*Leptograptus capillaris* (Carr).Distal theca. Enlargement of part of
Pl. XV, fig. 4 b.

merely as slight notches in the wall of the stipe. The apertures of th. 1¹ and th. 1² are, however, conspicuous and mucronate. The mature thecae have a length of about 2 mm. and are in contact for one-half to one-third of their length.

Affinities.—*L. capillaris* may be readily distinguished from all other *Leptograpti* by the extreme tenuity of its stipes and their pronounced curvature.

Horizon and Localities.—Lower Hartfell.

S. Scotland: Hartfell Spa; Ettrick Bridge End; Belcraig Burn.

Associates.—*L. capillaris* is an abundant form in the upper zones of the Lower Hartfell Shales, having a characteristic gregarious habit. It is found most frequently in the zone of *Pleurog. linearis*, where it occurs associated with *L. flaccidus*, *Diplog. truncatus*, var., and other forms. A few specimens have been recorded from rather lower horizons. Good specimens are in the collections of Lapworth and the Geological Survey of Scotland, and the types are in the British Museum.

Leptograptus validus, Lapworth MS. Plate XVI, figs. 1 a—c.

Polypary several centimetres in length; stipes somewhat rigid or but very slightly flexed, diverging at a wide angle from a conspicuous sicula, wide at origin and increasing gradually to a maximum breadth of about 1 mm., which is maintained for the greater part of their length. Thecae ten to eleven in 10 mm., inclined at about 10°, free two-thirds to one-half their length. Apertural margins circular, entire, slightly concave when compressed, nearly perpendicular to the axis of the stipe, and occupying about one-half of its width.

Description.—The stipes are typically rigid, but may be slightly flexed; this slight flexure is variable, but is commonly at first convex, while later the stipes show a decided tendency to grow horizontally. There is nothing approaching the conspicuous flexure of *L. flaccidus* and its varieties, var. *spinifer* and var. *mucilentus*. At their origin the stipes measure .6 mm. in breadth, and widen gradually up to .9 mm. Commonly when compressed the dimensions are slightly in excess of those just quoted, .7 mm. being the width near the sicula and 1 mm. the maximum breadth.

The sicula has a length of about 1.5 mm., and is somewhat broad in proportion; th. 1¹ originates about .5 mm. above the aperture, and the two crossing canals are as a rule very conspicuous and easier of detection than in some other species, owing to the greater breadth of the polypary in its initial region.

FIG. 68 a.—*Leptograptus validus*, Lapw.
MS.Reverse view. Enlargement of part of
Pl. XVI, fig. 1 a.

The apertures of the proximal thecæ are slightly mucronate. The thecæ in the maturer parts of the stipes have an average length of 2 mm., their free outer walls are straight, and the apertures are wide.

FIG. 68 b.—*Leptograptus validus*, Lapw. MS.



Distal thecæ in full relief. Enlargement of Pl. XVI, fig. 1 c.

Affinities.—*L. validus* is allied to *L. flaccidus*, but differs in the mode of growth of the stipes, and in the characters of the thecal apertures, which are

typically entire even at the proximal end.

Horizon and Localities.—Upper Llandeilo (Rorrington Flags). Glenkiln Shales?

Shropshire: Spy Burn. *S. Scotland*: Glenkiln Burn?

Associates, etc.—*L. validus* is a very common fossil at certain horizons, and in S. Shropshire it occurs rarely in the *Nemagraptus* (*Cœnograptus*) beds, and in profusion in the beds immediately overlying them at Spy Burn, the specimens being usually preserved in full or half relief. It is associated with *Didymog. superstes*, *Dicellog. sp.*, *L. latus*. Good specimens are in the collections of Lapworth, H.M. Geological Survey, and the Woodwardian (Sedgwick) Museum.

Var. *incisus*, Lapworth MS. Plate XVI, figs. 2 a, b.

Var. *incisus* agrees with *L. validus* in general form, but differs in having less closely set thecæ, and in the wide and oblique character of the thecal apertures. The sicula also is slightly longer than in the typical form.

The stipes are always slender, and commonly somewhat rigid, though they may be very slightly flexed; they have a width of about .4 mm. at the proximal end, and widen very gradually up to a breadth of .7 mm.

The sicula is conspicuous, it has a length of 2 mm., and its aperture is entirely concealed in the reverse aspect of the polypary. The first theca (th. 1st) originates basally, and grows at once obliquely outward and slightly downward. The crossing canals are practically horizontal, so that the apertures of the thecæ on the primary and secondary stipes come to lie at much the same level and distance from the sicula, and hence the appearance at the proximal end is very symmetrical.

FIG. 69 a.—*Leptograptus validus*, var. *incisus*, Lapw. MS.



Reverse aspect. Enlargement of part of Pl. XVI, fig. 2 a.

FIG. 69 b.—*Leptograptus validus*, var. *incisus*, Lapw. MS.



Distal thecæ. Enlargement of part of Pl. XVI, fig. 2 b.

The thecæ number nine to eight in 10 mm., though there may be as many as ten close to the sicula; each theca is inclined at 12°, has an average length of about 2 mm., a uniform width of about .3 mm., and is free from two-thirds to one-half of its extent. The apertural margins are slightly concave when compressed, submu-

ronate and introverted; they occupy two-thirds to one-half of the entire breadth of the stipe.

Affinities.—Var. *incisus* is characterised by the tenuity of its stipes, the length of its sicula, and the great width of the apertures of its thecæ relatively to the breadth of the stipe. As regards the tenuity of its stipes, var. *incisus* somewhat resembles *L. flaccidus*, var. *macer*, but differs in its mode of growth and in the characters of the thecæ.

Horizon and Localities.—Glenkiln Shales.

S. Scotland: Soven Burn, Wanlock Head.

Associates, etc.—Var. *incisus* occurs but rarely in the Glenkiln Shales of S. Scotland, where it is found associated with the typical Glenkiln fauna.

The best specimens, including the type, are in Lapworth's collection.

Note.

In addition to the forms of *Leptograptus* just described, there occur in the Skiddaw Slates of the Lake District numerous fragments the specific determination of which is inadvisable, if not impossible.

The thecæ on these fragments are well seen, and are clearly of the Leptograptid type, but the stipes are so fragmentary that it is impossible to imagine their original sweep. These are therefore figured (Pl. XVI, figs. 3 *a*, *b*), but not described.

Horizon and Localities.—Upper Skiddaw Slates (Ellergill beds).

Lake District: Bassenthwaite Sand-beds; Aik Beck.

Leptograptus grandis, Lapworth MS. Plate XVI, figs. 4 *a*—*d*.

Stipes robust, somewhat rigid, 3—4 cm. (or more) in length, widening gradually from origin, and diverging from the middle of a fairly conspicuous sicula so as to include an angle of about 210°. Thecæ ten to nine in 10 mm., inclined at 10°, six times as long as wide, free about one-half their length. Apertural margins submucronate, straight or slightly concave when compressed, slightly introverted, occupying one-half to one-third the breadth of the stipe.

Description.—The stipes are somewhat rigid, but may occasionally be stiffly

FIGS. 70 *a* and *b*.—*Leptograptus grandis*, Lapw.
MS.



a. Obverse view. Enlargement of part of Pl. XVI, fig. 4 *a*.

b. Reverse view. Enlargement of part of Pl. XVI, fig. 4 *a*.

curved; they are .6 mm. wide at their origin and increase up to a maximum breadth of rather more than 1.5 mm.

The sicula is fairly long, it has a length of 1.5—1.6 mm., and is broad in proportion. The origin of the stipes is submedian, and the thecæ grow outward and slightly down-

ward at once, so that a considerable portion of the apertural region of the sicula is visible in both aspects of the polyptych. The crossing canals are horizontal.

FIG. 70 c.—*Leptograptus grandis*, Lapw.
MS.



Distal thecae. Enlargement of part of
Pl. XVI, fig. 4 c.

The thecae are about 2—3 mm. in length, and the apertures occupy more than one-half the width of the stipe proximally, and from one-half to one-third of the width in the more distal parts. The proximal thecae are distinctly mucronate.

Affinities.—*L. grandis* is somewhat closely allied to *L. latus* in point of size and in the width of the stipes, but differs in the character of the proximal end, the more median origin of the stipes, and in having fewer thecae in the same unit of length.

Horizon and Locality.—Glenkiln Shales.

S. Scotland: Glenkiln Burn.

Associates, etc.—*L. grandis* is a somewhat rare fossil in the Glenkiln Shales of S. Scotland, where it occurs associated with *Diplog. ? perexaratus*, *Climacog. bicornis*, etc., etc. The best specimens known to us are in Lapworth's collection.

***Leptograptus latus*, sp. nov.** Plate XVI, figs. 5 a—e.

Polyptych several cm. in length, stipes comparatively rigid, widening rapidly from their origin to a maximum breadth of 1·4 mm., and diverging at a wide angle from a conspicuous sicula. Thecae twelve to fourteen in 10 mm., inclined at 10°—25°, five times as long as wide, and free two-thirds to one-third of their length; apertural margins concave when compressed, occupying about one third of the total breadth of the stipe.

Description.—The polyptych is characterised by the rapid widening of the stipes and the relatively great breadth finally attained. The stipes may be very gently curved at the proximal end, and may even undulate slightly throughout their length, but there is a general absence of the pronounced curvature characteristic of most species of *Leptograptus*: the width near the proximal end is about 1·4 mm., widening within 5 cm. to the maximum breadth of 1·4 mm.

FIG. 71 a.—*Leptograptus latus*, sp. nov.



Reverse view. Enlargement of part of
Pl. XVI, fig. 5 c.

The sicula has a length of 1·5 mm., and th. 1¹ apparently originates about 1·6 mm. above the aperture. Thecae 1¹, 1², and 2¹ and 2² have mucronate apertures.

The free outer walls of the thecae appear almost straight in some aspects, whereas in others they appear markedly curved. Their inclination varies conspicuously in different parts of the stipes; near the proximal end they are inclined at 10° and are in contact for about one-third of their extent, but both the inclination and the amount of

overlap increase distally, so that eventually the inclination amounts to 25° , and the thecæ are in contact for two-thirds of their length. Hence the reason for the increase in width.

FIG. 71 b.—*Leptograptus latus*, sp. nov.



Distal thecæ. Enlargement of part of Pl. XVI, fig. 5 d.

Contrary to what obtains in most *Leptograpti*, the thecæ are more distant in the proximal region (twelve in 10 mm.) and closer set nearer the distal ends of the stipes (fourteen in 10 mm.). The

apertures are concave and oblique, and are situated in deep excavations.

Affinities.—*L. latus* is allied to *L. grandis* in general form and size, but differs in the more rapid increase in width of the stipes and in having a greater number of thecæ in the same unit of length.

The habit and the form of the thecæ in this species points in the direction of the *Dicellograpti*, and it may possibly be regarded as a transitional form between the two genera *Leptograptus* and *Dicellograptus*.

Horizon and Locality.—Upper Llandeilo (Rorrington Flags).

S. Shropshire: Spy Burn.

Associates.—*L. latus* is found not infrequently in the *Nemagraptus* (*Cænograptus*) beds of Spy Burn, associated with *Nemag.* (*Cænog.*) *gracilis*, and also occurs rarely at the same locality in the *Leptog. validus* beds above. The best specimens known to us are in the collection of H.M. Geological Survey.

***Leptograptus ascendens*, sp. nov. Plate XVI, figs. 6 a, b.**

Stipes narrow, flexed, generally crossing each other once in a length of 2 cm., widening gradually from origin to a width of rather less than 1 mm. Sicula long, narrow, with conspicuous apertural spine. Thecæ narrow, ten to nine in 10 mm., inclined at 10° , about six times as long as wide, and free two thirds to one half their length. Apertural margins straight or slightly concave, occupying about one third the width of the stipe; those of the two earliest thecæ furnished with short spinous processes.

The stipes diverge from a conspicuous sicula at an angle of about 270° , but generally show at once graceful convex curvature, and bend towards each other till they cross at a point about 1 cm. vertically above the sicula; the stipe also is twisted on its own axis, so that the thecæ continue to lie on the outside of the curve.

The sicula measures about 1.2 mm. in length, exclusive of its apertural spine, which is clearly defined; the spinous processes on th. 1¹ and th. 1² are also of the nature of apertural spines, but none of the later developed thecæ have any ornamentation of this nature.

The thecæ are well seen; they widen slightly in the direction of their apertures,

and are especially conspicuous in the proximal region, where the amount of overlap is reduced to a minimum, and where the apertures occupy nearly the entire width of the stipe. In the more distal regions, however, the amount of overlap increases up to one-half, the thecæ have a length of 2 mm., and the thecal apertures only occupy one-third of the total width of the stipe.

Affinities.—*Leptograptus ascendens* approaches in general form the two allied species of *Dicellograptus*, *D. intortus* and *D. caduceus*. It differs from either of these in the character of the thecæ, which belong clearly to the *Leptograptus* rather than to the *Dicellograptus* type. From all other *Leptograpti* it may be distinguished by its scandent form.

Horizon and Localities.—Glenkiln Shales (zone of *Nemag.* [*Cœnog.*] *gracilis*).

S. Scotland: Foot of Hawkwood Burn, Abington; Pulmaddy Burn, near Carsphairn.

Associates, etc.—This species has as yet only been found in the Glenkiln Shales of S. Scotland, where it occurs associated with such typical forms as *Nemag.* (*Cœnog.*) *gracilis*, *Dicellog. sextans*, and *Didymog. superstes*.

The type specimens are in the collection of the Geological Survey of Scotland.

Specific Characters of Forms belonging to the Genus Leptograptus.

	<i>L. flaccidus.</i>	VAR. <i>spinifer.</i>	VAR. <i>macilentus.</i>	VAR. <i>macer.</i>	VAR. <i>arcuatus.</i>	<i>L. capillaria.</i>	<i>L. validus.</i>	VAR. <i>incisus.</i>	<i>L. grandis.</i>	<i>L. latus.</i>	<i>L. ascendens.</i>
Character of stipes.	Graceful double curvature in proximal region ultimately horizontal	Straight or with irregular curvature	Rigid or stiffly curved	Narrow, with slight and variable curvature	Slightly sigmoid curvature	Slender and markedly sigmoid curvature	Somewhat rigid or but very slightly flexed, wide at origin	Slender and somewhat rigid	Rigid, or very slightly flexed, wide throughout	Markedly rigid and widening rapidly	Strongly curved so as to cross each other.
Maximum width of stipes	1 mm.	0·8—1 mm.	1 mm.	0·6 mm.	1 mm.	0·5 mm.	1 mm.	0·7 mm.	1·5 mm.	1·4 mm.	1 mm.
Length of sicula	1·5—1·6 mm.	2 mm.	1·6—2 mm.	2 mm.	2 mm.	2 mm.	1·5 mm.	2 mm.	1·5—1·6 mm.	1·5 mm.	1·2 mm.
No. of thecæ in 10 mm.	10—8	9—10	9—8	6	7—8	8—10	10—11	10—8	10—9	12—14	10—9.
Inclination	15°	15°	15°	Same as typical species	Same as typical species	—	10°	12°	10°	10°—25°.	
Overlap	$\frac{1}{3}$ — $\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$ — $\frac{1}{3}$	Ditto.	Ditto.	$\frac{1}{2}$	$\frac{1}{3}$ — $\frac{1}{2}$	$\frac{1}{3}$ — $\frac{1}{2}$	$\frac{1}{2}$	$\frac{2}{3}$	0— $\frac{1}{2}$.

Genus **PLEUROGRAPTUS**, *Nicholson*.

1867. *Pleurograpsus*, Nicholson, Geol. Mag., vol. iv, p. 257.

Polypary bilaterally symmetrical, consisting of two uniserial main stipes, which diverge from the scula at angles slightly exceeding 180° , and from one margin (or both) of which numerous, usually irregularly disposed, secondary uniserial branches are given off. These secondary branches may be simple or compound.

Thecæ of the type of *Leptograptus*.

The whole appearance of the *Pleurograptus* polypary is characteristically slender, though its dimensions vary with the age and size of the individual. The scula is but rarely well preserved, though its position is usually clearly indicated; from it or its immediate neighbourhood, as in the *Leptograpti*, a central stipe or branch is frequently developed, but in *Pleurograptus* this branch appears to resemble more closely the secondary branches given off from the main stipes, rather than the main stipes themselves. The secondary branches resemble in most particulars the main stipes from which they arise, and the same is also true of the tertiary branches; but while the main stipes of the polypary increase gradually in breadth throughout their length, the width of the secondary and tertiary branches is approximately uniform, and is the same as that of the main stipe at the point where the secondary branches are given off.

Systematically, *Pleurograptus* is best regarded as a *Leptograptus*, from the main stipes of which numerous simple or compound secondary branches are given off at irregular intervals. One species only is known at present, *P. linearis*, and this shows great variation in the sweep of the main stipes, and in the number and distribution of the secondary branches. One of these variations appears to be more or less permanent, and as it is not an uncommon fossil, we have distinguished it as var. *simplex*.

Pleurograptus linearis (Carruthers). Plate XVI, fig. 7; Plate XVII, fig. 1.

1858. *Cladograpsus linearis*, Carruthers, Trans. Roy. Phys. Soc. Edinburgh, p. 467, fig. 1.

1859. *Cladograpsus linearis*, Carruthers, Ann. Mag. Nat. Hist. [3], vol. iii, p. 24, fig. 3.

1867. *Dendrograpsus linearis*, Carruthers, Geol. Mag., vol. iv, p. 70.

1867. *Pleurograpsus linearis*, Nicholson, Geol. Mag., vol. iv, p. 257, pl. xv, figs. 1—5.

1876. *Pleurograptus linearis*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 69.

Main stipes of great but unknown length, widening gradually and persistently from their origin to a maximum breadth of about 1 mm. Secondary and

tertiary branches several centimetres in length, but often short compared with the main stipes, and of uniform width throughout their length. Sicula rarely visible. Thecae uniformly narrow, occupying about one third the width of stipe, seven to eight in 10 mm., inclined at about 10° , eight times as long as wide; free two-thirds to one-half their length. Apertural margins narrow, slightly concave when compressed, introverted.

Description.—The polypary of this form must have attained an enormous size; a perfect specimen has never been seen by the Authors, but Carruthers states that he has traced one for nearly 70 cm. (3 feet.) There is frequently a certain amount of curvature in the main stipes near their proximal end, but the flexibility varies greatly in different individuals. The secondary branches are given off quite irregularly, and generally occur on one side only, but in some specimens they appear on either side of the main stipe indiscriminately; this, however, may be merely due to the position in which the polypary came to rest, and therefore of no specific importance. The earliest secondary branches may be given off quite close to the sicula or at a distance comparatively remote from it. The secondary and tertiary branches commonly show slight convex curvature. Fragments of them may readily be distinguished from those of the main stipes by their uniform width, fragments of the main stipes showing an increase in breadth for the greater part of their length. The main stipes are exceedingly narrow at their origin, never, apparently, exceeding .2 mm. in breadth; the maximum width observed on any fragment is 1 mm., but in the specimens which attain the enormous length mentioned by Carruthers it is possible that this dimension may be exceeded. The width of each secondary or tertiary branch is the same as that of the parent stipe at the point at which it is given off.

The sicula is rarely visible, as in most of the complete specimens it gives rise to a third stipe or branch. Siculae found in association with such forms probably belong to the species, and are about 2 mm. in length.

The thecae number seven to eight in 10 mm., the lower number being found near the sicula, where the overlap is less than in the maturer parts of the stipes. Each theca when fully developed has a length of 2—2.5 mm., is free for two thirds of its length proximally, but subsequently overlaps approximately one half of its extent. The thecal apertures usually occupy about one third of the total width of the stipe, but near the sicula the apertures are so minute that they are hardly visible to the naked eye, and the polypary frequently appears as a narrow unbroken line.

Centribrachiate forms of *P. linearis* are of common occurrence.

Horizon and Localities.—Hartfell Shales.

S. Scotland: Dobb's Linn; Hartfell Spa; Mount Benger Burn; Craigmichan Seours; Rowantree Gutter; Thirlstone Seaur; Ettrick Bridge End, etc.

Associates.—*P. linearis* occurs in abundance in one special zone in the Hartfell Shales, where slabs of rock may be obtained entirely covered with fragments of it.

It is commonly associated with *Leptog. flaccidus* and its varieties, *Diplog. truncatus*, and other *Diplograpti* of the "foliaceus" type. There are good specimens in the collections of H.M. Survey, the Woodwardian (Sedgwick) Museum, the British Museum, and in the private collections of Lapworth and the Authors.

Var. **simplex**, Lapworth MS. Plate XVII, fig. 2.

Description.—This variety of *Pleurog. linearis* is one in which the main stipes have usually a wider sweep, and in which the secondary branches, which are simple, are few in number, generally only three on each main stipe; their disposition, moreover, is more regular than in the typical form, there being about 1.5 cm. between each branch.

FIG. 72.—*Pleurograptus linearis*, var. *simplex*, Lapw. MS.



Thecae of main stipe near proximal end. Enlargement of part of Pl. XVII, fig. 2.

The sicula in the type specimen gives rise to a central stipe or branch.

The thecae agree in all particulars with those of the typical form.

Horizon and Locality.—Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Hartfell Spa.

Associates, etc.—Var. *simplex* occurs in some abundance in the Hartfell Shales in the zone of *Pleurog. linearis*, associated with the zone fossil and various *Diplograpti*. The type specimen is in Lapworth's collection, and there are others in the Authors' collections.

Genus **AMPHIGRAPTUS**, Lapworth.

1873. *Amphigraptus*, Lapworth, "Notes on the British Graptolites and their Allies," Geol. Mag., vol. x, p. 559.

Polypary rigid, bilaterally subsymmetrical, consisting of two uniserial main stipes, diverging from the sicula at an angle of approximately 180°, which give off regularly or irregularly disposed, rigid, simple or compound secondary branches constituting a more or less radiate polypary.

Thecae of the characteristic *Leptograptus* type, with low inclination and small amount of overlap.

The *Amphigraptus* polypary is characterised by the straightness and rigidity of both stipes and branches, and their approximately radial disposition.

The main stipes are, generally speaking, narrow, but they vary in width from

·5 mm. to 1 mm. in the different examples, so that some are relatively wide when compared with others.

The secondary branches agree with the main stipes in all essential characters; they usually originate in the early stages of growth of the main stipes, being absent at their more distal extremities, but this is not invariably the case; they are typically disposed in pairs, but there is considerable diversity in the arrangement of these pairs, and in some cases one member of the pair appears to be suppressed (*A. divergens*, var. *radiatus*).

As in *Leptograptus*, a central stipe, or branch, is frequently developed from the sicula or its immediate neighbourhood.

The thecae are rarely shown compressed in true profile, their apertures either facing, or being opposed to the view of the observer; this condition of preservation seems to be due to the radial disposition of the branches.

The genus *Amphigraptus* is somewhat rare in British deposits, and has only been found in the Hartfell Shales in the zones of *Dicranog. clingani* and *Pleurog. linearis*, and it is exceedingly rare in the first-named zone.

The following forms may be recognised as belonging to the genus :

A. divergens ; *A. divergens*, var. *radiatus* ; *A. distans*.

Amphigraptus divergens (Hall). Plate XVIII, fig. 1.

1859. *Graptolithus divergens*, Pal. New York, vol. iii, Suppl., p. 509, fig. 9.

1865. *Graptolithus divergens*, Hall, Grapt. of Quebec Group, pp. 12, 13, fig. 11.

1876. *Amphigraptus divergens*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 70.

Main stipes narrow, 11 cm. or more in length, straight and somewhat rigid, or very slightly curved throughout, diverging at about 180° from the sicula, which is rarely distinguishable. Secondary branches, simple or compound, 5—6 cm. or more in length, also somewhat rigid or with very slight curvature; apparently arranged in pairs, usually three in number, on either side of the sicula and in close proximity to it. Thecae long and narrow, eight to nine in 10 mm., inclined at 10°, about eight times as long as wide, free for two thirds their length. Apertural margins introverted, occupying about one third the total width of the stipe.

Description.—The main stipes and secondary branches appear to be of approximately uniform breadth for the greater part of their length; they are about ·8 mm. wide, except at their point of origin where they are rather less. The secondary branches are very occasionally compound.

FIG. 73.—*Amphigraptus divergens* (Hall).



Distal theca. Enlargement of part of specimen on same slab as Pl. XVIII, fig. 1.

The sicula appears to be ·7 mm. in length.

The thecæ are very long and narrow, having a length of fully 2 mm.

Remarks.—Hall notes that there is great irregularity in the length of the stipes, but this would seem to be a matter of preservation.

Affinities.—*A. divergens* differs from all other known *Amphigrapti* in the position and number of the secondary branches; there are usually not fewer than three pairs of these on either side of the sicula, and all branching takes place within a distance of 3 mm. from the sicula, so that there is an appearance of "close packing" of the branches.

Horizon and Localities.—Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Mount Benger Burn; Hartfell Spa; Earl's Hill.

Associates, etc.—This species seems to be confined to the zone of *Pleurog. linearis* and is not of common occurrence; it has been found associated with *Pleurog. linearis*, *Leptog. flaccidus*, and *Climacog. tubuliferus*.

The figured specimen, and others upon which the description is based, are in Lapworth's collection. The specimen originally figured by Lapworth ('Cat. West. Scott. Foss.,' pl. iii, fig. 70) has unfortunately been mislaid.

Var. *radiatus*, Lapworth. Plate XVIII, figs. 2*a*—*d*.

1876. *Amphigraptus radiatus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 71.

Description.—Another *Amphigraptus* which is found in the Hartfell Shales, and which appears to be best regarded as a variety of *A. divergens*, is the one to which the name var. *radiatus* has been given.

The polypary of the type specimen is conspicuously radiate in form, being composed of two main stipes and three branches, making five in all; there is one branch only on each main stipe, one member of each pair being presumably suppressed, and in addition there is a central branch developed from the sicula or its immediate neighbourhood. The form is, in fact, a centribrachiate mutation of one in which there are usually only two main stipes and two branches, making four in all. These two forms, then, are to be considered as constituting one and the same variety, the difference merely lying in the presence or absence of the centribrachiate stipe or branch.

The main stipes are generally about 4 cm. in length and have a uniform breadth of 1 mm.; the secondary branches agree with the main stipes in all essential characteristics, and have also a length of about 4 cm.

The sicula is but rarely preserved; it appears to have a length of about 1·2 mm.

The thecæ number ten in 10 mm.; they are

FIG. 71.—*Amphigraptus divergens*, var. *radiatus*, Lapw.



Enlargement of part of Pl. XVIII, fig. 2*b*.

inclined at 10° , have an average length of 1.5 mm., and are free for two thirds of it. The apertural margins occupy about one half the width of the stipe.

Affinities.—The polypary of var. *radiatus* is obviously somewhat closely allied to that of *A. divergens*, since the secondary branching takes place in close proximity to the sicula; it only differs from *A. divergens* in its capacity for branching, which appears to be much less than that of the typical form.

Horizon and Localities.—Hartfell Shales (zones of *Dicranog. Clingani* and *Pleurog. linearis*).

S. Scotland: Dobb's Linn; Hartfell Spa; Castle Hill, Abington; Cairn Burn.

Associates, etc.—Var. *radiatus* has been recorded from the zones of *Dicranog. Clingani* and *Pleurog. linearis* in the Hartfell Shales of S. Scotland, where it occurs in association with *Climacog. caudatus* and *Leptograptus*. Specimens are in the collections of Lapworth, the Woodwardian (Sedgwick) Museum, and the Geological Survey of Scotland.

Amphigraptus distans, sp. nov. Plate XVIII, fig 3.

Main stipes narrow, straight and rigid, 3 cm. or more in length, diverging at an angle of less than 180° from a conspicuous sicula, which frequently gives rise to an extra stipe. Secondary branches agreeing with main stipes in general characters, but somewhat shorter, given off in pairs or sets of pairs, with a distance of at least 5 mm. between each set. Thecae seven in 10 mm., inclined at about 10° , having an average length of 2.5 mm. and free for two thirds of it. Apertural margins submucronate, slightly introverted, occupying about one third the total width of the stipe.

Description.—The main stipes and secondary branches have an average width of .5 mm., but perhaps slightly less at their origin. The length of the main stipes was probably not less than 4 cm., while that of the secondary branches seems not to have exceeded 3 cm.

A third stipe, or branch, is developed from the sicula or its neighbourhood, in the type specimen, so that the details of the proximal end cannot be made out accurately. The sicula appears to have a length of 1 mm. or more.

The thecae are long; in the figured specimen they are well preserved.

FIG. 75.—*Amphigraptus distans*, nov.



Thecae of one of branches. Enlargement of PL. XVIII, fig. 3.

Affinities.—*A. distans* is characterised by the distance between the sets of secondary branches; this distance is far greater than that of any species belonging to this genus hitherto described. It approaches *A. divergens* in the number of its secondary branches, but differs in their position and arrangement; for instead of being close packed they are spread

out over a considerable distance along the main stipes. The characters of the thecae are somewhat similar to those of *A. divergens*.

Horizon and Localities.—Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Rowantree Cleuch, Kirkhope Burn; Barskeoch Burn.

Associates, etc.—Only a few specimens have been found; one is recorded from the Hartfell Shales which occur in the heart of a fold in a small stream flowing into the Kirkhope Burn, another from Barskeoch Burn. They are in the collection of the Geological Survey of Scotland.

Note.

An interesting form of Leptograptid is figured on Pl. XVIII, fig. 4. Only one specimen, however, has been found, and its affinities are so doubtful that it is merely figured and not named.

The main stipes are sigmoidally curved and the branches are given off partly in pairs and partly irregularly. The sicula, as figured, is conspicuous, but it is clearly seen to underlie the stipe, and its position may not be the normal one. The thecae, which number eleven to ten in 10 mm. are of the ordinary Leptograptid type.

Affinities.—In the curvature of the main stipes this form approaches a *Nemagraptus*, but the mode of branching is rather of the type of an *Amphigraptus*. It is doubtfully referred to this latter genus.

Horizon and Locality.—Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Mount Benger Burn?

Associates, etc.—This form occurs associated with *Diplograptus*, sp., and is in Lapworth's collection.

NEMAGRAPTUS, Emmons (CÆNORGAPTUS, Hall).

1855. *Nemagraptus*, Emmons, American Geology, vol. i, p. 169.

1866. *Stephanograptus*, Geinitz, "On Hall's Graptolites of the Quebec Group," Neues Jahrb. f. Min., p. 124.

1868. *Helicograptus*, Nicholson, Ann. Mag. Nat. Hist. [4], vol. ii, p. 26.

1868. *Cænograptus*, Hall, 20th Ann. Report on State Cabinet, p. 217.

Polypary bilateral, symmetrical, consisting of two slender uniserial main stipes more or less flexed, which may be directed upward, outward, or downward at varying angles, and which originate from the central part of a well-defined sicula. From each of these two main stipes, symmetrically or sub-symmetrically disposed secondary branches may be given off.

Thecae long and narrow, of the general type of *Leptograptus*, with low inclination and small amount of overlap.

The origin of the two main stipes from the central part of the sicula gives a characteristic appearance to this genus, the persistent sicula itself always resembling a central "radicular bar."

Another characteristic feature is constituted by the regularity of the secondary branching as contrasted with the general irregularity of the branching in the genera already described.

The earliest form recognised as belonging to this genus was the *Graptolithus gracilis* of Hall, figured and described by him in his 'Palæontology of New York,' 1847. The same form was afterwards described and figured by Emmons in his 'American Geology,' 1855, and made the type of a new genus—*Nemagraptus* (*Nemagraptus elegans*). Although Emmons's figure and description are somewhat indifferent, yet it is clear both from his figures, and from the circumstance that the associates of his *N. elegans* are those of *Gr. gracilis*, that the two are the same.

In 1865 Hall himself, in his 'Graptolites of the Quebec Group,' p. 43, wrote that Emmons's typical species of *Nemagraptus (elegans)* is "apparently a part of an individual of *Graptolithus gracilis*, or some similar species." Geinitz, however, in his review of Hall's work (1866), proposed the name of *Stephanograptus* for this form, and in 1868 Nicholson suggested the title of *Helicograptus*. In the same year Hall, ignoring Emmons's earlier generic name, proposed the name *Cænograptus*.

The titles *Stephanograptus* and *Helicograptus* are both of older date than *Cænograptus*, but *Nemagraptus* has the priority over both. We are compelled, therefore, to employ Emmons's name of *Nemagraptus* for this genus, but having regard to the fact that *Cænograptus* has been in general use for thirty years, and has entered into geological nomenclature as the name of a special geological horizon, we have placed it in brackets after Emmons's designation for the sake of reference and convenience.

The *Nemagrapti* may be classified into the following two groups:

GROUP I.—Type <i>N. gracilis</i>	GROUP II.—Type <i>N. explanatus</i> .
<i>N. gracilis</i>	<i>N. explanatus</i> .
var. <i>surcularis</i>	var. <i>pertenus</i> .
var. <i>remotus</i>	
var. <i>nitidulus</i>	

Group I.—Type *N. gracilis*.

Nemagrapti in which the main stipes are usually curved in a sigmoid fashion and give off numerous secondary branches.

Nemagraptus gracilis (Hall). Plate XIX, figs. 1a—f.

1847. *Graptolithus gracilis*, Hall, Pal. New York, vol. i, p. 274, pl. lxxiv, figs. 6a, b, c, d.
 1851. *Rastrites Barrandi*, Harkness, Quart. Journ. Geol. Soc., vol. xi, p. 475.
 1855. *Nemagraptus elegans*, Emmons, American Geology, vol. i, p. 109, pl. i, fig. 6.
 1859. *Graptolithus gracilis*, Hall, Pal. New York, vol. iii, Suppl., p. 510, fig. 5.
 1862. ? *Graptolithus gracilis*, Baily, Quart. Journ. Geol. Soc. (Dublin), vol. ix, p. 5, pl. iv, fig. 5.
 1865. *Graptolithus gracilis*, Hall, Grapt. of Quebec Group, p. 13, fig. 16; p. 14, fig. 17.
 1866. *Stephanograptus gracilis*, Geinitz, Neues Jahrb. f. Min., p. 124.
 1867. ? *Graptolithus gracilis*, Baily, Mem. Geol. Survey Ireland, Sheet 133, p. 12, fig. 3.
 1868. *Cladograptus gracilis*, Carruthers, Geol. Mag., vol. v, p. 130.
 1868. *Cœnograptus gracilis*, Hall, 20th Ann. Rep., p. 217, figs. 17 (?), 18, 19.
 1868. *Helicograptus gracilis*, Nicholson, Ann. Mag. Nat. Hist. [4], vol. ii, p. 25, fig. 1.
 1876. *Cœnograptus gracilis*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 65.
 1877. *Cœnograptus gracilis*, Lapworth, Proc. Belfast Nat. Field Club, p. 142, pl. vii, fig. 11.

Main stipes from 2—4·5 cm. in length, but never exceeding 6 mm. in width, diverging from a conspicuous sicula at 180°, but immediately after showing marked curvature in opposite directions, forming a broad S-shaped bend. From the outer side of each curve secondary branches are given off at regular intervals, commencing close to the sicula, then curving in same direction as main stipe from which they arise. Thecae seven to nine in 10 mm., inclined 10°—15°, about 2 mm. in length, six times as long as wide, free for two-thirds to three-quarters their length. Apertural margins concave, slightly introverted.

Description.—The main stipes of the polypary are most conspicuously curved. The secondary branches are often of great length, and curve in the same direction as their main stipe, but to a smaller extent. These secondary branches increase in width from 4 mm. to 9 mm.; they vary very much in length and in number, according to the age of the individual. Fully developed forms may have as many as fourteen secondary branches on each main stipe, while in young individuals the number may not exceed three or four. The earliest secondary branches are always developed close to the sicula, the first at a distance of about 2·5 mm. from the sicula, and the rest 1·5—2 mm. apart; each appears to arise opposite the aperture of a theca.

The sicula is small (1 mm.), but owing to its central position and to the slender nature of the polypary it is always conspicuous.

FIG. 76 a.—*Nemagraptus gracilis* (Hall).

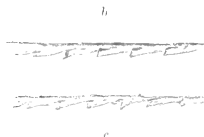
Proximal end. Enlargement of part of Pl. XIX, fig. 1 c.

The first theca seems to originate at a point midway between the apex and the aperture of the sicula, or perhaps very slightly nearer to its aperture; the crossing canal is horizontal, and th. 1¹ and th. 1² are of approximately equal length, so that the whole

appearance of the proximal end is very symmetrical. The apertures of *th. 1*¹ and *th. 1*² are distinctly mucronate, a feature which is not observable in any of the later developed thecae. These appear to develop in the normal manner for the most part, but the interthecal wall between the two first thecae developed on either side of the sicula seems, in some of the adult forms, to have grown completely back to the sicular wall.

The thecae on the main stipes are hard to distinguish, as they are frequently concealed except at the distal extremities of the stipes. To this fact is probably due the view of the earlier palaeontologists that the main stipes were non-polypiferous. The general tendency seems to be for them to appear in preservation on the outer side of the curve of each stipe which is turned in the upward direction, but in the case of the stipe turned in the downward direction they show sometimes on the inner side of the curve and sometimes on the outer side. Their position on the inner side of the curve is probably the normal one, but on the polypary coming to rest the presence of the secondary branches seems to have produced slight torsion of this downward-growing stipe and tended to *drag round* the thecal-bearing margin to the outer side of the curve, hence in preservation the thecae are frequently seen in such a position. Additional evidence of such torsion can sometimes be detected near the proximal end where the first theca of the downward-growing stipe is seen on the under side in its normal position; but where the first secondary branch is given off there is an obvious twist of the main stipe, and the second theca appears on the opposite side of the stipe to the first.

FIGS. 76 *b* and *c*.—*Nemagraptus gracilis* (Hall).



b. Thecae of one of the branches in low relief. Enlargement of part of Pl. XIX, fig. 1 *a*.
c. Ditto.

The thecae are of the normal *Leptograptid* type on both the main stipe and the secondary branches, though the ventral (marginal) excavation is somewhat small. The thecae on the main stipes are slightly more remote than those on the secondary branches—seven as compared with eight in 10 mm.; the amount of overlap is also less, the thecae on the main stipe being only just in contact, while on the secondary branches the overlap may be as much as one third their entire length.

Affinities.—The typical form of *N. gracilis* is allied to var. *remotus*; it may, however, be readily distinguished by the number and position of its secondary branches. From all other *Nemagrapti* it differs in the direction of growth taken by the two main stipes, *i. e.* in the presence of the sigmoid bend.

Horizon and Localities.—Upper Llandeilo (Glenkiln).

Wales: Tiddyndicwm; Builth Road; Porth Badrig, Anglesea. *Shropshire*: Spy Burn; Holywell Burn, etc. *S. Scotland*: Beleraig Burn; Glenkiln Burn; Rein Gill; Berrybush Burn; Tributary of Crawick Water, Sanquhar; Bail Hill; Rough Gill; Hawkwood Burn; Gair Gill; Riddenlees; Fingland Burn; Cowie's

Linn; Kelphepe Burn; Papana Water; Horten Gill; Duntercleuch; Black Linn, etc. *Ireland*: Ballygrot; Craigavad; Tramore Bridge.

Associates, etc.—*Nemag. gracilis* is one of the commonest fossils wherever the Graptolitic facies of the Upper Llandeilo rocks is developed; throughout S. Scotland it occurs in abundance where the central members of the Glenkiln beds occur. It is commonly associated with *Didymog. superstes*, *Dicellog. sectans*, *Dicranog. zig-zag*, *D. tardiusculus*, *D. ramosus*, *Leptog. latus*, *N. explanatus*, and var. *pertenuis*, *N. gracilis*, var. *surcularis*, *Diplog. Whitfieldi* and other forms. Excellent specimens are in the collections of the Geological Survey of Scotland and the private collections of Lapworth and the Authors.

Var. **surcularis** (Hall). Plate XIX, figs. 2 *a*—*d*.

1868. *Cænograptus surcularis*, Hall, 20th Ann. Report on State Cabinet, p. 179, figs. 13—16.

1876. *Cænograptus surcularis*, Lapworth, Cat. West. Scot. Foss., pl. iii, fig. 64.

1877. *Cænograptus surcularis*, Lapworth, Proc. Belfast Nat. Field Club, p. 143, pl. vii, fig. 12.

Description.—In addition to *Nemag. gracilis*, there occurs associated with it another somewhat closely allied form in which the flexed main stipes, instead of growing one upward and one downward, are both directed upward, and are curved in such a manner that they tend to cross each other at some point along their length. These main stipes have a length of 1—2 cm., do not exceed .5 mm. in width, and their direction of growth is extremely characteristic. The secondary branches are short, being about 7.5 mm. in length, and their width is also uniformly .5 mm.; they are commonly few in number (about four on each stipe), are only slightly curved, and are situated near the sicula. The average distance between the secondary branches is 1.5 mm., and each branch appears to originate opposite the aperture of a theca on the main stipe.

FIG. 77 *a*.—*Nemagraptus gracilis*, var. *surcularis* (Hall).

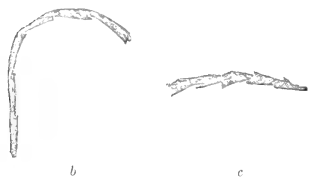


Proximal end. Enlargement of part of Pl. XIX, fig. 2 *a*.

The sicula is conspicuous; it has a length of about 1 mm., and the nema can frequently be detected at its apical extremity. In the obverse aspect of the polypary the earliest developed thecae are seen to originate approximately midway between the apex and aperture of the sicula, but rather nearer to its aperture; they grow slightly downward before curving outward, and the appearance of the proximal end is characteristically symmetrical; the

apertures of th. 1¹ and th. 1² are submucronate at their lower extremities, and the first intertheical walls appear to grow back to the sicula.

FIGS. 77 b and c.—*Nemagraptus gracilis*, var. *surcularis* (Hall).



b. Thecae at distal end of main stipe. Enlargement of Pl. XIX, fig. 2 a.
c. Thecae of one of the branches. Enlargement of Pl. XIX, fig. 2 a.

The thecae are always preserved on the outer side of the curve of the stipes; they are rather more remote on the main stipes than on the secondary branches (seven instead of eight in 10 mm.). They are inclined at about 10° , have an average length of 1.5 mm., are six times as long as wide, and overlap one-third of their length.

Affinities.—Var. *surcularis* is very closely allied to *N. gracilis*, but it has a different fashion of growth. It was regarded by Hall as a young form of *N. gracilis*, but if so the direction of the stipes must have been modified at a later stage of growth of the species, for no large form preserving the aspect of var. *surcularis* has as yet been found on either side of the Atlantic, although small forms of the type of *N. gracilis* are not uncommon. We can only consider that they are the same form if we imagine that in the later stages of growth one branch underwent torsion. There appears to be a certain amount of evidence for this view, but it is too small to justify the inclusion of the two under one name.

Horizon and Localities.—Upper Llandeilo (Glenkiln).

S. Scotland: Cairn Hill; Glenkiln Burn; Berrybush; Rein Gill; Gair Gill; Riddendees; Papana Water; Black Linn; Dibbin Lane, etc. *N. Ireland*: Ballygrot.

Associates, etc.—Var. *surcularis* is a comparatively common form in the Glenkiln Shales of S. Scotland, where it occurs associated with *Didymog. superstes*, *Nemag. gracilis*, *Nemag. explanatus*, *Dicellog. sextans*, and *Diplograptus* sp. The best specimens at present known are in Lapworth's collection and in that of the Geological Survey of Scotland.

Var. remotus, var. nov. Plate XIX, figs. 3 a—h.

Description.—A second variety of *N. gracilis* in which the branching takes place entirely at the distal extremities of the main stipes is also fairly abundant in the Glenkiln Shales of S. Scotland. This is now described as var. *remotus*.

The main stipes in general show the sigmoid curvature characteristic of the typical species and have a length of 2 cm. or more; they are, however, narrower, never exceeding .3 mm. in width. From the outer side of the curve of each main stipe, and near their distal extremities, three or four (possibly more) short secondary branches are given off, and the curvature of these is similar in direction to that of the main stipe from which they arise. The first is developed at a distance of not less than 4 mm. from the sicula, and the subsequent ones are commonly 2 mm. apart.

FIG. 78.—*Nemagraptus gracilis*, var. *remotus*, nov.



Proximal end. Enlargement of part of Pl. XIV, fig. 3 d.

The sicula is about 1 mm. in length.

The thecae number ten in 10 mm., they are inclined at 10° , have an average length of 1.5 mm., are five times as long as wide, and are in contact for only a small fraction of their extent.

Affinities.—This species is closely allied to *N. gracilis* in general form, but differs in the position and number of the secondary branches and their greater tenuity; there are also more thecae in a given unit of length. From all other *Nemagrapti* it may be distinguished by the direction of growth of the main stipes.

Horizon and Localities.—Upper Llandeilo (Glenkiln).

S. Scotland: Belcraig Burn; Glenkiln Burn; Rein Gill; Morrach Bay. *Ireland*: Ballygrot.

Associates, etc.—Var. *remotus* occurs in the Glenkiln Shales of S. Scotland, associated with *Didymog. superstes*, *Dicellog. sextans*, *Nemag. gracilis*, etc. It is not a common form. The best specimens known are in the collections of the Geological Survey of Scotland, and the private collections of Lapworth and the Authors.

Var. **nitidulus** (Lapworth). Plate XIX, figs. 4 a—d.

1876. *Cænograptus nitidulus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 66.

Description.—A third variety is that to which Lapworth has given the name *nitidulus*. This is characterised by the tenuity of the stipes, which average .3 mm. in breadth, and the fact that the branches, which are few in number, are usually on the inner side of the curve. The main stipes have a length of about 2 cm. They diverge from a conspicuous sicula at an angle of about 180° , but after giving origin to two thecae curve upward so as to include a much smaller angle. They have a typical sigmoidal curvature, but being very flexed and slender this curvature is often extreme and irregular, and the stipes are bent back on themselves. There is generally evidence of one secondary branch on each main stipe, arising close to the sicula. These have a length of 7.5 mm. and a breadth of about .3 mm., though they are not perfectly uniform in width, undergoing a slight and almost imperceptible increase along their extent.

FIGS. 79 a and b.—*Nemagraptus gracilis*, var. *nitidulus* (Lapw.).



a. Obverse view.

b. Reverse view. Both specimens on same slab. Enlargement of part of Pl. XIX, fig. 4 b.

The sicula is conspicuous; it has a length of 1.3 mm. The first theca originates about midway between its apex and aperture, and grows downward and then outward; the initial portion of th. 1²

(crossing canal) is horizontal, as in most *Nemagrapti*, and thus in the reverse aspect of the polypary there is the usual appearance of symmetry in the proximal end.

FIG. 79 c.—*Nemagraptus gracilis*, var. *nitidulus* (Lapw.).



Distal theca. Enlargement of part of Pl. XIX, fig. 4 a.

The thecae are long and remote; they number seven in 10 mm. and are inclined at 10° , have an average length of 2 mm., are six times as long as wide, and free for three quarters of their extent. They have only been observed on the main stipes.

Affinities.—Var. *nitidulus* differs from all other known *Nemagrapti*, except var. *remotus*, in the tenuity of its stipes and their extreme flexibility. From var. *remotus*, however, it may be distinguished by the presence of only one branch arising in close proximity to the sicula. In the diminution of the capacity for branching var. *nitidulus* approaches the *Nemagrapti* of Group II.

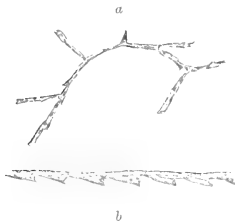
Horizon and Localities.—Upper Llandeilo (Glenkiln).

S. Scotland: Glenkiln Burn; Hawkwood Burn; Rein Gill.

Associates, etc.—Var. *nitidulus* is a somewhat rare fossil in the Glenkiln Shales of S. Scotland, where it occurs associated with *Nemag. gracilis*, *Nemag. explanatus*, *Dicellog. sextans*, *Diplograptus*, sp., etc. The type specimen and several good ones are in Lapworth's collection, while a few are in the collection of the Geological Survey of Scotland.

Note.

FIGS. 80 a and b.—*Nemagraptus*, sp.



a. Proximal extremity. Enlargement of part of Pl. XIV, fig. 5.

b. Distal theca. Enlargement of part of Pl. XIX, fig. 5.

Another form of *Nemagraptus*, of which only one specimen has as yet been found, is in the collection of the Geological Survey of Scotland, and is characterised by its pendant form (Pl. XIV, fig. 5). Each main stipe bears two secondary branches, and the thecae number eight in 10 mm.

Should more specimens be found proving the permanence of this form, it might be separated as a distinct species under the name of *N. descendens*.

Horizon and Locality.—Glenkiln Shales.

S. Scotland: Craighure Lodge, Head of Stinchar.

Group II.—Type *N. explanatus*.

Nemagrapti in which the stipes are but slightly curved, and diverge from the sicula at a wide angle. The secondary branches are few in number.

Nemagraptus explanatus (Lapworth). Plate XIX, figs. 6*a*—*c*.

1876. *Cænograptus explanatus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 68.

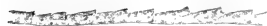
Main stipes 6 cm. or more in length and .6—8 mm. in width, straight or with slight curvature, diverging from a conspicuous sicula at 180°, but subsequently curving upward and outward so as to include a smaller angle; from the thecal margin (commonly the upper side) one or more straight or slightly curved secondary branches are given off. Thecae eight in 10 mm., inclined at about 10°, about 2 mm. long, six times as long as wide, free two-thirds to three-quarters their length. Apertural margins concave, introverted.

Description.—In their ultimate direction of growth the main stipes include a widely open angle and grow approximately straight. The secondary branches are comparatively short, not exceeding 2 cm. as a general rule, and also have a uniform width of .6—8 mm.; there is commonly one, but occasionally evidence of two on each main stipe, and the first of these is given off at some distance from the sicula.

The sicula is conspicuous; it has a length of about 1 mm. The point of origin of the stipe is median, the crossing canal being horizontal; the apertures of th. 1¹ and th. 1² are not so distinctly mucronate as in some forms, but the interthecal wall developed between the first two thecae on either side of the sicula appears frequently to grow back to the wall of the sicula.

The thecae are fairly closely set.

FIG. 81.—*Nemagraptus explanatus*
(Lapw.).



Distal theca. Enlargement of part of
Pl. XIX, fig. 6 *c*.

Affinities.—*N. explanatus* is characterised by the general tenuity of its stipes, their wide angle of divergence, and the presence of one or more secondary branches. From all the *Nemagrapti* of the *N. gracilis* group it may be distinguished by its habit. Fragments are liable to be confused with fragments of var. *portensis*, but may be distinguished by the more numerous thecae in a given unit of length, and by the presence of secondary branches.

Horizon and Localities.—Upper Llandeilo (Glenkiln).

S. Scotland: Belcraig Burn; Glenkiln Burn; Cairn Hill; Craigmichan Scaur; Rein Gill; Hawkwood Burn; Berrybush; Black Linn, etc. *N. Ireland*: Ballygrot.

Associates, etc..—*N. explanatus* is a fairly common form in the Glenkiln Shales of S. Scotland, where it occurs associated with *Nemag. gracilis*, var. *surcularis*, *Dicranog. ramosus*, *Lasioagraptus*, sp., etc. Specimens, including the type, are in Lapworth's collection; there are also a few in the collection of the Geological Survey of Scotland and the Authors.

Var. *pertenus* (Lapworth). Plate XIX, figs. 7 a—f.

1876. *Cænograptus pertenus*, Lapworth, Cat. West. Scott. Foss., pl. iii, fig. 67.

1877. *Cænograptus pertenus*, Lapworth, Proc. Belfast Nat. Field Club, p. 143, pl. vii, fig. 13.

1899. ? *Leptograptus antiquus*, T. S. Hall, Geol. Mag., dec. iv, vol. vi, p. 448, pl. xxii, figs. 5, 6.

Description.—There occur in association with *N. explanatus* forms in which the stipes are somewhat more flexed and the thecæ slightly more remote; in addition there seem to be no secondary branches in the same unit of length. No complete specimens are known, so that it is impossible to say with certainty whether there are any secondary branches, but there are none within the same distance of the sicula as there are in *N. explanatus*.

The sicula has a length of 1·2 mm. when complete, but is frequently broken.

The thecæ number six to seven in 10 mm., they are inclined at about 10°, are 2·5 mm. in length, and free for three quarters of their extent; they are about six times as long as wide. The apertural margins are concave and introverted.

Affinities.—Var. *pertenus* is obviously most closely allied to *N. explanatus*, but is distinguished from the typical form by the general absence of branching and the greater remoteness of the thecæ.

In the general absence of branching it suggests a connection with the *Leptograpti*, but on account of the fragmentary nature of the specimens and its close relationship with *N. explanatus* it seems advis-

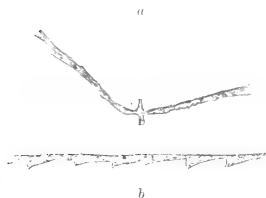
able, for the present at any rate, to retain it with the *Nemagrapti*.

Horizon and Localities.—Upper Llandeilo (Glenkiln).

S. Scotland: Birnock Water; Rein Gill; Glenkiln Burn; Belcraig Burn; Blackburn; Crawick Water, head of R. Stinchar; Hawkwood Burn; Gair Gill; Riddendenes; Cowie's Linn; Kelphope Burn; Papana Water; Horten Gill; Duntercleuch; Kiln Burn, etc. *N. Ireland*: Ballygrot.

Associates, etc.—Var. *pertenus* is an abundant form in the Glenkiln Shales of S. Scotland, where it occurs in association with *Nemag. gracilis*, var. *surcularis*, *Dicellog. sectans*, *Dicranog. rectus*, *Dicranog. ramosus*, *Diplograptus*, sp., and other forms. It also occurs with similar associates in N. Ireland. There are good specimens in the collections of the Geological Survey of Scotland, Lapworth, and the Authors. The type specimen is in Lapworth's collection.

FIGS. 82 a and b.—*Nemagraptus explanatus*, var. *pertenus* (Lapw.).



a. Proximal extremity. Enlargement of part of Pl. XIX, fig. 7 c.
b. Distal thecæ. Enlargement of part of Pl. XIX, fig. 7 a.

PLATE XIV.

Genus **Leptograptus**, Lapworth.

FIGS.

1 *a—g.*—*Leptograptus flaccidus* (Hall).

- 1 *a.* Typical form. Hartfell Spa, Moffat. Hartfell Shales (zone of *Pleurog. linearis*). Lapworth's Collection.
- 1 *b.* Typical form, preserved in low relief. Mount Benger Burn. Hartfell Shales. Geological Survey of Scotland, Edinburgh Museum.
- 1 *c.* Smaller specimen, with a slightly more irregular curvature of the stipes. Hartfell Spa. Hartfell Shales (zone of *Dicranog. Clingani*). Lapworth's Collection.
- 1 *d.* Larger specimen with typical curvature. On same slab as fig. 1 *c.*
- 1 *e.* Centribrachiate form. Hartfell Spa. Hartfell Shales. Lapworth's Collection.
- 1 *f.* Ibid.
- 1 *g.* Centribrachiate form, showing four extra branches. On same slab as fig. 1 *e.*

2 *a—c.*—*Leptograptus flaccidus*, var. *spinifer*, Elles and Wood, nov.

- 2 *a.* Typical specimen, well preserved in low relief. Hartfell Spa. Hartfell Shales. Lapworth's Collection.
- 2 *b.* Specimen with well-developed spines on the proximal thecæ. Ibid.
- 2 *c.* Broader form with strongly curved stipes, doubtfully referable to this variety. Ibid.

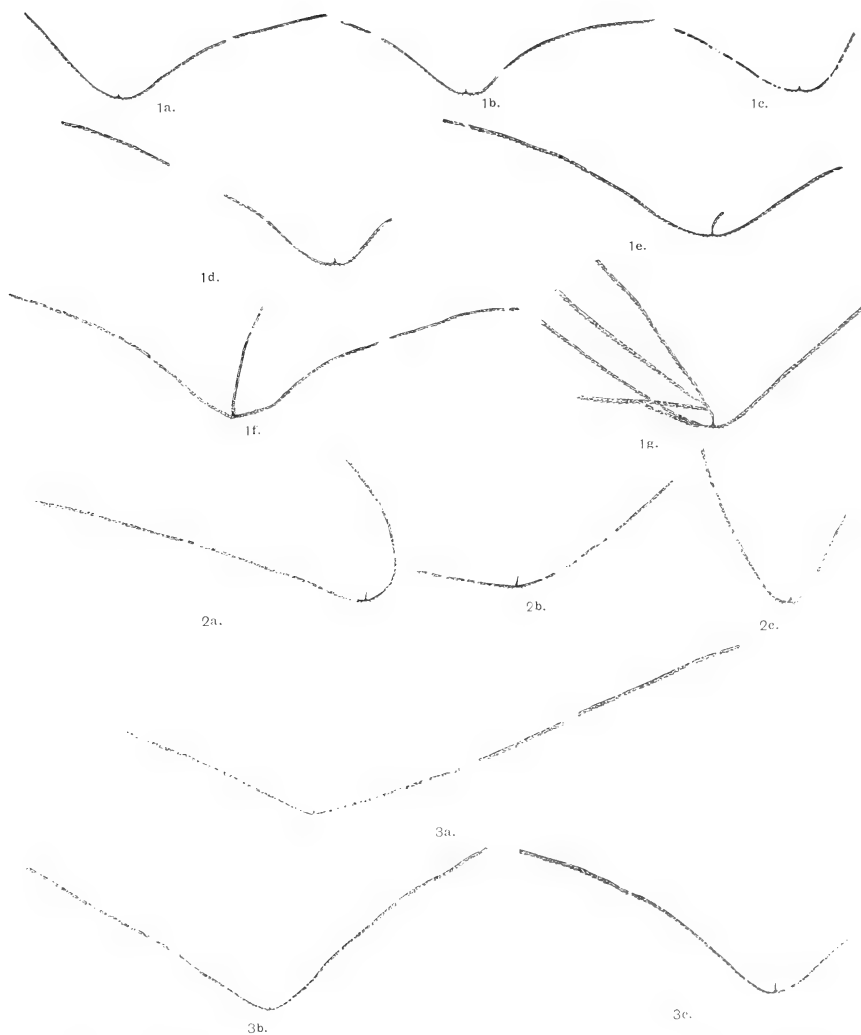
3 *a—c.*—*Leptograptus flaccidus*, var. *macilentus*, Lapworth, MS.

- 3 *a.* Typical form, with somewhat rigid stipes. Hartfell Spa. Hartfell Shales (zone of *Pleurog. linearis*). Lapworth's Collection.
- 3 *b.* Stipes more flexed. On same slab as fig. 3 *a.*
- 3 *c.* Specimen showing complete sícula. On same slab as figs. 3 *a*, 3 *b*.

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PLATE XIV.



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R. G. G. G. G.

LEPTOGRAPTUS.

PLATE XV.

Leptograptus—*continued*.

FIGS.

1 *a—c*.—*Leptograptus flaccidus*, cf. var. *macilentus*, Lapworth, MS.

1 *a*. Large, strongly curved specimen. Hartfell Spa, Moffat. Hartfell Shales. Lapworth's Collection.

1 *b*. Ibid.

1 *c*. Straighter form with conspicuous sicula. On same slab as fig. 1 *b*.

2 *a—i*.—*Leptograptus flaccidus*, var. *macer*, Elles and Wood, nov.

2 *a*. Portion of a slab showing specimens in association. Hartfell Spa. Hartfell Shales. Elles' Collection.

2 *b*. Two specimens in association. Belcraig Burn. Hartfell Shales (zone of *Pleurog. linearis*). Wood's Collection.

2 *c*. More flexed form with prominent sicula. Hartfell Spa. Hartfell Shales. Wood's Collection.

2 *d*. Isolated stipe. On same slab as fig. 2 *c*.

2 *e*. Well-preserved specimen. Hartfell Spa. Hartfell Shales. Wood's Collection.

2 *f*. Centribrachiate form. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

2 *g*. Flexed form. Belcraig Burn. Hartfell Shales. Wood's Collection.

2 *h*. Double centribrachiate form. Hartfell Spa. Hartfell Shales. Wood's Collection.

2 *i*. Ditto?, or *Amphigraptus*? On same slab as fig. 2 *h*.

3 *a—c*.—*Leptograptus flaccidus*, var. *arcuatus*, Elles and Wood, nov.

3 *a*. Symmetrically curved form. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

3 *b*. Typical form with sigmoid curvature. On same slab as fig. 3 *a*.

3 *c*. Ditto. On same slab as figs. 3 *a* and 3 *b*.

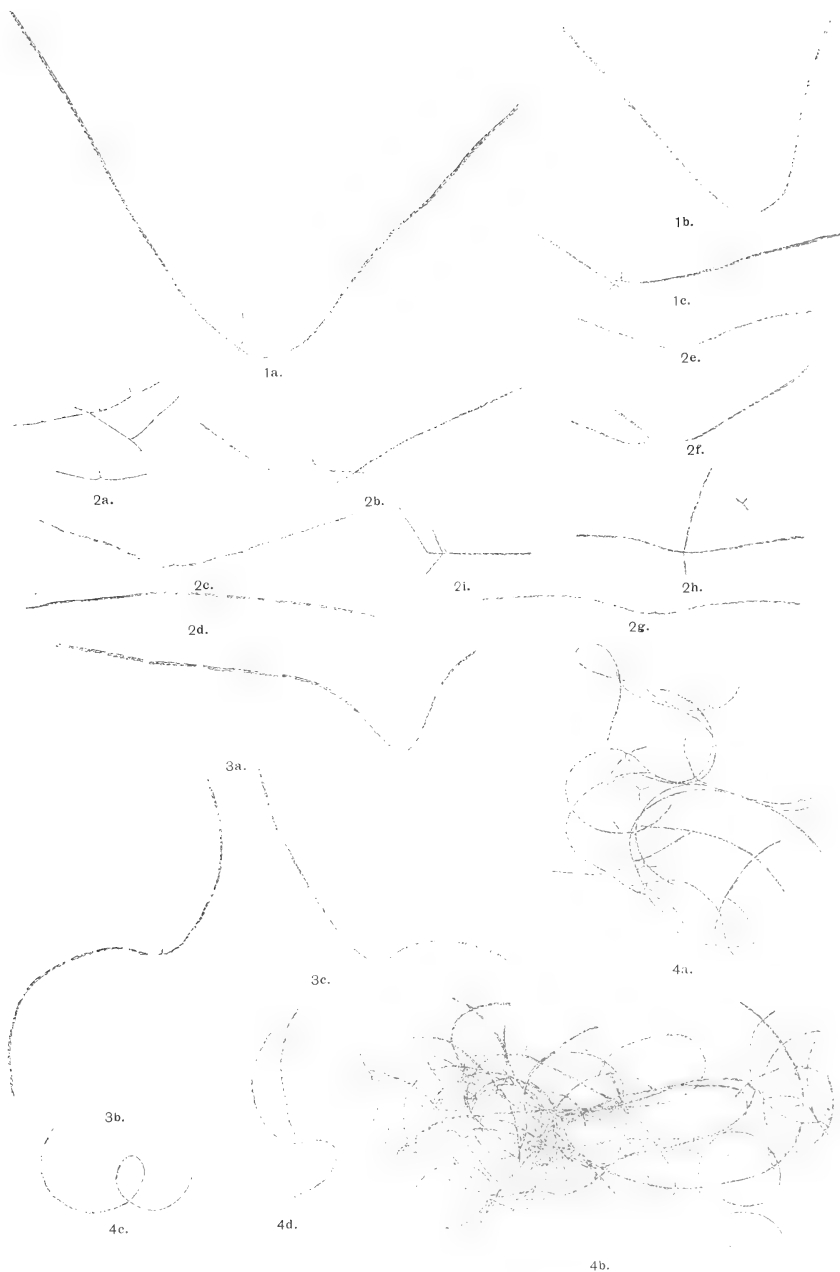
4 *a—d*.—*Leptograptus capillaris* (Carruthers).

4 *a*. Type specimen. Figured, Carruthers, Geol. Mag., 1868, vol. v, pl. v, fig. 7 *a*. Hartfell Spa? Hartfell Shales. British Museum (Natural History), S. Kensington.

4 *b*. Part of a slab, showing general habit of the species. Hartfell Spa. Hartfell Shales. Lapworth's Collection.

4 *c*. Single stipe, showing curvature. Ibid.

4 *d*. Centribrachiate form. Belcraig Burn. Hartfell Shales (zone of *Pleurog. linearis*). Elles' Collection.



E. M. R. Wood, del.

LEPTOGRAPTUS.

B. M. R. Wood, del.



PLATE XVI.

Leptograptus—continued—and Pleurograptus, Nicholson.

FIGS.

1 a—e.—*Leptograptus validus*, Lapworth, MS.

- 1 a. Typical specimen, in relief. Spy Burn, Shropshire. Rorrington Flags (*Leptog. validus* Beds). H.M. Geological Survey Collection.
- 1 b. Somewhat broader form. Spy Burn, Shropshire. Rorrington Flags (*Nemagraptus* [*Cænograptus*] Beds). H.M. Geological Survey Collection.
- 1 c. Isolated stipe in full relief. Spy Burn, Shropshire. Rorrington Flags (*Leptog. validus* Beds). H.M. Geological Survey Collection.
- 1 d. Isolated stipe, not in relief. Spy Burn. Rorrington Flags (*Leptog. validus* Beds). Lapworth's Collection.
- 1 e. More curved form, showing sicula. On same slab as fig. 1 d.

2 a, b.—*Leptograptus validus*, var. *incisus*, Lapworth, MS.

- 2 a. Typical form, showing the sicula. Sown Burn, Wanlock Head, nr. Sanquhar. Glenkiln Shales. Lapworth's Collection.
- 2 b. Distal part of isolated stipe. Ibid.

3 a, b.—*Leptograptus*, sp.

- 3 a. Isolated stipe in good preservation. Bassenthwaite Sand-beds. Upper Skiddaw Slates. Postlethwaite's Collection.
- 3 b. Isolated stipe, showing rapid widening. On same slab as fig. 3 a.

4 a—d.—*Leptograptus grandis*, Lapworth, MS.

- 4 a. Specimen showing general form. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.
- 4 b. Specimen with stipes diverging at a wider angle. On same slab as fig. 4 a.
- 4 c. Isolated stipe, showing great width. On same slab as figs. 4 a and 4 b.
- 4 d. Well-preserved specimen, showing details of proximal end. Glenkiln Burn? Glenkiln Shales. Lapworth's Collection.

5 a—e.—*Leptograptus latus*, Elles and Wood, sp. nov.

- 5 a. Very large specimen, preserved in low relief. Spy Burn, Shropshire. Rorrington Flags (*Leptograptus* Beds). H.M. Geological Survey Collection.
- 5 b. Typical specimen, showing rapid widening. Spy Burn, Shropshire. Rorrington Flags (*Nemagraptus* [*Cænograptus*] Beds). H.M. Geological Survey Collection.
- 5 c. Well-preserved, typical specimen. Ibid.
- 5 d. Isolated stipe, distal part. On same slab as fig. 5 b.
- 5 e. Obverse view. Spy Burn. Rorrington Flags (*Nemagraptus* [*Cænograptus*] Beds). H.M. Geological Survey Collection.

6 a, b.—*Leptograptus ascendens*, sp. nov.

- 6 a. Typical form with stipes crossed. Foot of Hawkwood Burn, Abington. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
- 6 b. Specimen with stipes less curved and uncrossed. Pulmaddy Burn, nr. Carsphairn, Kirkcudbrightshire. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.

7.—*Pleurograptus linearis* (Carruthers).

Type specimen. Figured, Nicholson, Geol. Mag., 1867, vol. iv, pl. xi, fig. 1; and Monograph of British Graptolites, p. 111. Hartfell Spa. Hartfell Shales. British Museum (Natural History), S. Kensington.

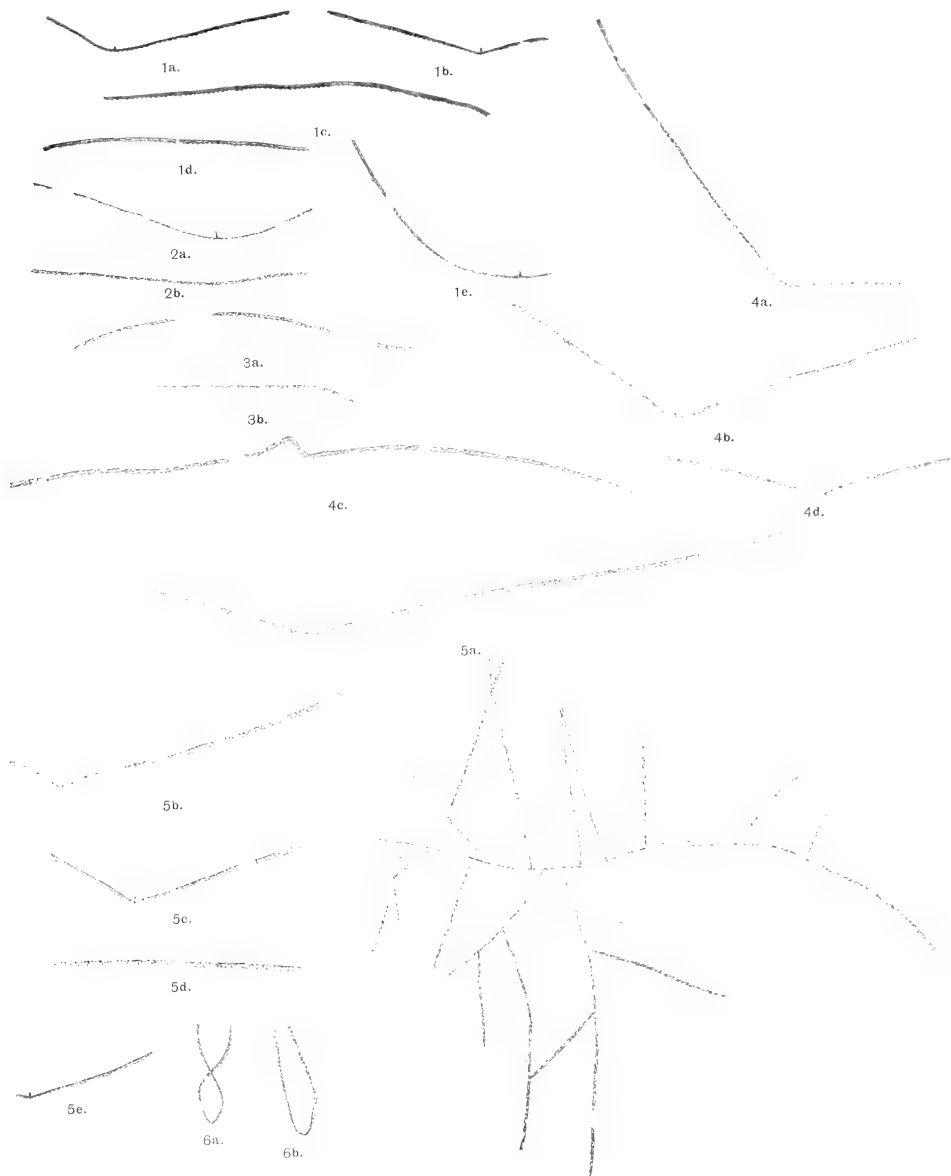




PLATE XVII.

Pleurograptus—*continued*.

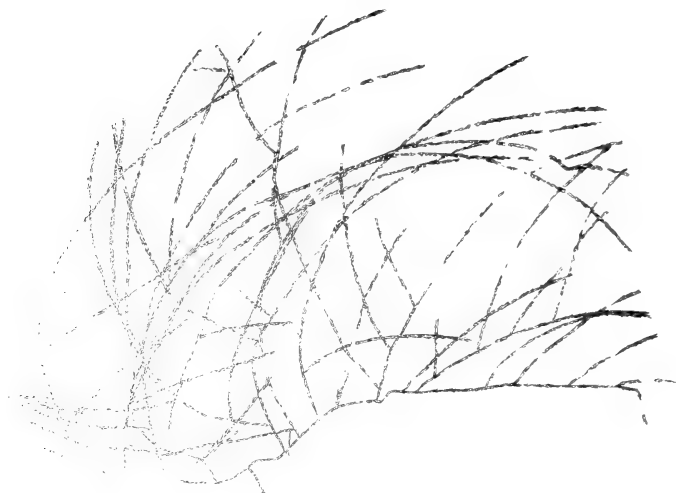
FIGS.

1.—*Pleurograptus linearis* (Carruthers).

Large specimen showing numerous simple and compound branches.
Hartfell Spa, Moffat. Hartfell Shales. Lapworth's Collection.

2.—*Pleurograptus linearis*, var. *simplex*, Lapworth, MS.

Specimen with only a few simple branches. Hartfell Spa. Hartfell
Shales. Lapworth's Collection.



1.



2.

P. M. R. W. L. L.

P. M. R. W. L. L.

PLEUROGRAPTUS.

PLATE XVIII.

Genus **Amphigraptus**, Lapworth.

FIGS.

1.—*Amphigraptus divergens* (Hall).

Large specimen, well preserved. Mount Benger Burn, Selkirkshire.
Hartfell Shales. Lapworth's Collection.

2 a—c.—*Amphigraptus divergens*, var. *radiatus*, Lapworth.

2 a. Type specimen. Figured, Lapworth, Cat. West. Scott. Fossils,
1876, pl. iii, fig. 71. Hartfell Spa, Moffat. Hartfell Shales (zone
of *Pleurog. linearis*). Lapworth's Collection.

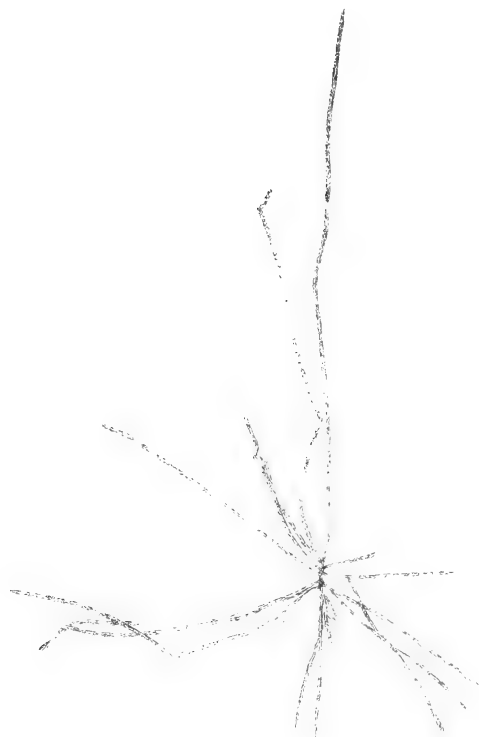
2 b. Specimen with only four branches. Ibid.

2 c. Narrow specimen, poorly preserved. Hartfell Spa. Hartfell
Shales. Geological Survey of Scotland, Edinburgh Museum.

3.—*Amphigraptus distans*, Elles and Wood, sp. nov.

Type specimen. Barskeoch Burn, near St. John's, Dalry, Kirkcud-
brightshire. Hartfell Shales. Geological Survey of Scotland, Edinburgh
Museum.

4.—*Amphigraptus*? sp. Mount Benger Burn, Selkirkshire. Hartfell Shales.
Lapworth's Collection.



1.



2a.



2b.



3.

2c.

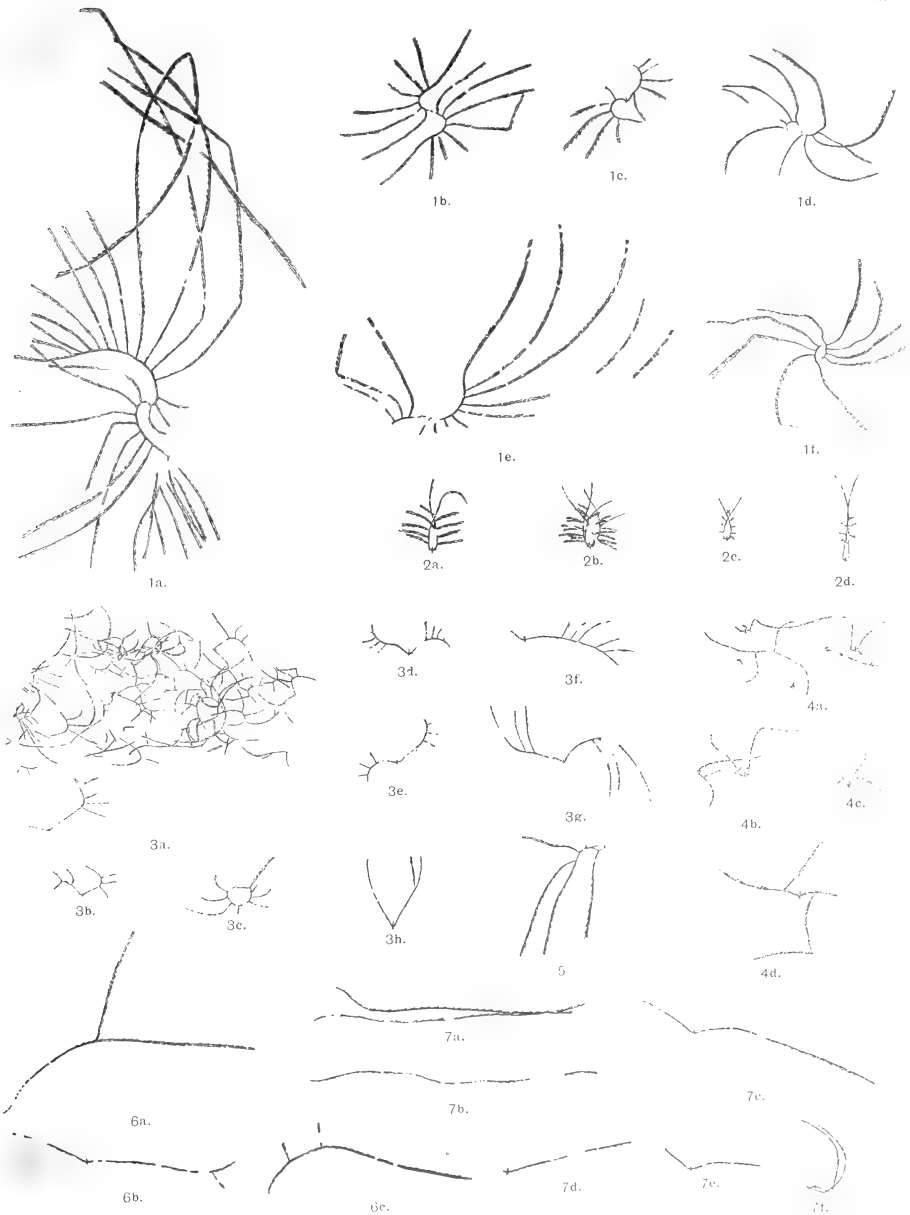
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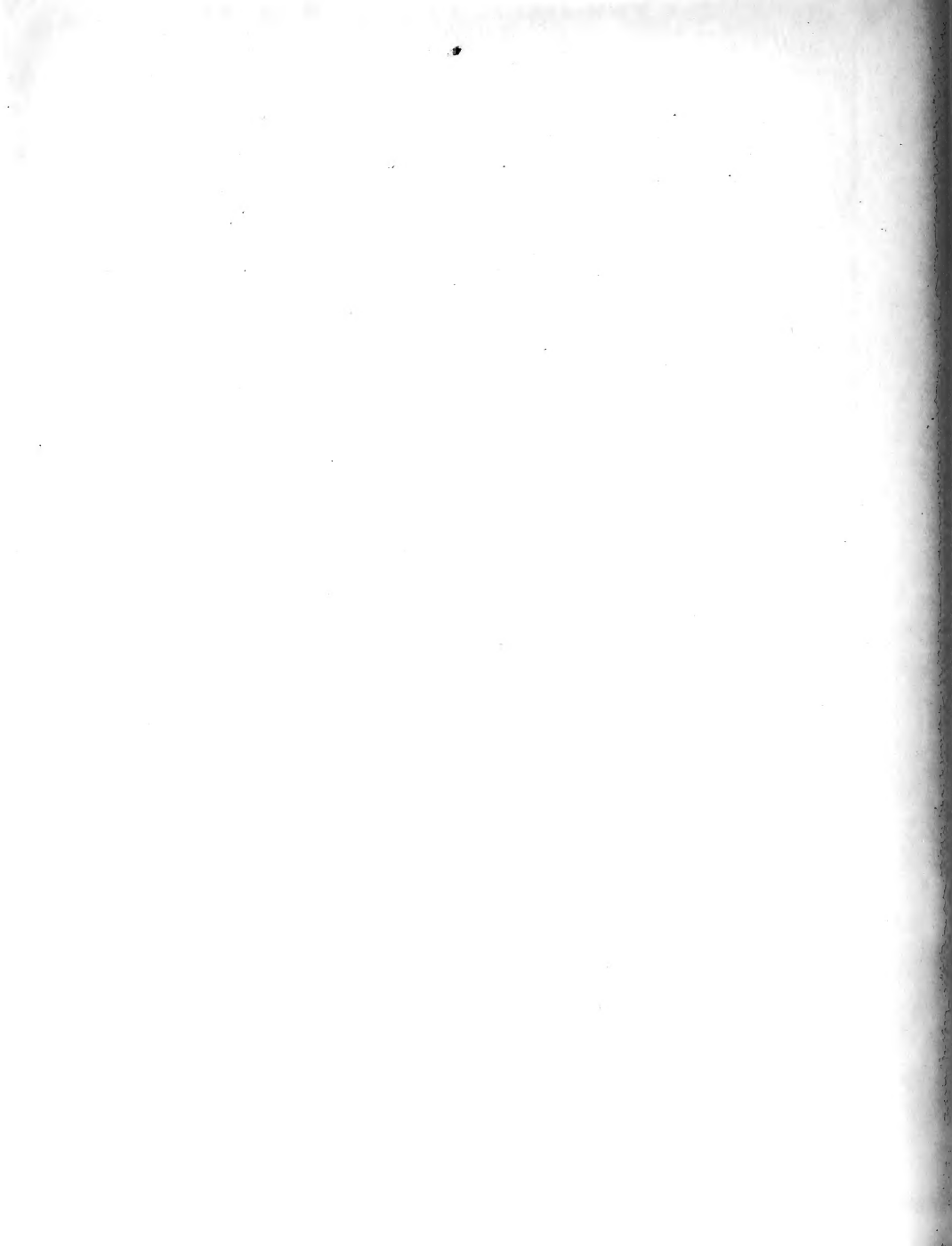
PLATE XIX.

Genus **Nemagraptus** (*Cænograptus*, Hall), Emmons.

- 1 *a-f.*—*Nemagraptus gracilis* (Hall).
 - 1 *a.* Very large specimen, well preserved, partly in low relief. Bail Hill, Sanquhar. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
 - 1 *b.* Typical form. Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iii, fig. 65. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.
 - 1 *c.* Specimen showing sicula. Berrybush Burn, St. Mary's Loch, Selkirkshire. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
 - 1 *d.* Specimen preserved in low relief. Spy Burn, Shropshire. Rorrington Flags. H.M. Geological Survey Collection.
 - 1 *e.* Portion of large specimen. Belcraig Burn. Glenkiln Shales. Elles' Collection.
 - 1 *f.* Specimen preserved in low relief. Spy Burn, Shropshire. Rorrington Flags. H.M. Geological Survey Collection.
- 2 *a-d.*—*Nemagraptus gracilis*, var. *sicularis* (Hall).
 - 2 *a.* Typical form. Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iii, fig. 64. Cairn Hill, Euchar Water, nr. Sanquhar. Glenkiln Shales. Lapworth's Collection.
 - 2 *b.* Two specimens in close association. Ibid.
 - 2 *c.* Small specimen, showing the apertural spine of the sicula. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.
 - 2 *d.* Elongated specimen. Belcraig Burn. Glenkiln Shales. Lapworth's Collection.
- 3 *a-h.*—*Nemagraptus gracilis*, var. *remotus*, Elles and Wood, nov.
 - 3 *a.* Part of a slab, showing numerous specimens in association. Rein Gill, Wandel Water, Lanarkshire. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
 - 3 *b.* Specimen on same slab as fig. 3 *a.*
 - 3 *c.* Ditto? On same slab as figs. 3 *a* and 3 *b.*
 - 3 *d.* Characteristic form, well preserved. Cairn Hill? Glenkiln Shales. Lapworth's Collection.
 - 3 *e.* Specimen showing general form, poorly preserved. Belcraig Burn. Glenkiln Shales. Wood's Collection.
 - 3 *f.* Fragment of larger specimen. Ballygrot, co. Down. Glenkiln Shales. Lapworth's Collection.
 - 3 *g.* Large specimen, but with few branches. Morrach Bay, Portpatrick. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
 - 3 *h.* Specimen showing only one branch. Morrach Bay, Portpatrick. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
- 4 *a-d.*—*Nemagraptus gracilis*, var. *nitidulus* (Lapworth).
 - 4 *a.* Portion of a slab, showing three specimens in association. Cairn Hill, Euchar Water. Glenkiln Shales. Lapworth's Collection.
 - 4 *b.* ? Type specimen. ? Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iii, fig. 66. Ibid.
 - 4 *c.* Small specimen. Belcraig Burn. Glenkiln Shales. Lapworth's Collection.
 - 4 *d.* Large specimen, poorly preserved. Birnock Water, Abington. Glenkiln Shales. Lapworth's Collection.
- 5.—*Nemagraptus*, sp.

Well-preserved specimen, showing pendent form of the stipes. Craiglure Lodge, Head of Stinchar. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.
- 6 *a-c.*—*Nemagraptus explanatus* (Lapworth).
 - 6 *a.* Type specimen. Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iii, fig. 68. Glenkiln Burn. Glenkiln Shales. Lapworth's Collection.
 - 6 *b.* Specimen showing the sicula. Cairn Hill? Glenkiln Shales. Lapworth's Collection.
 - 6 *c.* Fragment with two branches. On same slab as fig. 2 *c.*
- 7 *a-f.*—*Nemagraptus explanatus*, var. *pertenuis* (Lapworth).
 - 7 *a.* Type specimen. Figured, Lapworth, Cat. West. Scott. Foss., 1876, pl. iii, fig. 67. Birnock Water, Abington. Glenkiln Shales. Lapworth's Collection.
 - 7 *b.* Fragmentary stipe. Ibid.
 - 7 *c.* Specimen showing sicula. Cairn Hill. Glenkiln Shales. Lapworth's Collection.
 - 7 *d.* Single straight stipe with sicula well shown. Glenkiln Burn? Glenkiln Shales. Lapworth's Collection.
 - 7 *e.* Ditto. On same slab as fig. 2 *a.*
 - 7 *f.* Two specimens strongly flexed. Rein Gill, Wandel Water, Lanarkshire. Glenkiln Shales. Geological Survey of Scotland, Edinburgh Museum.







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